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Falling Bleachers The annual crop of grandstand failures is now being harvested. One man was killed and several seriously injured two weeks ago at Tulsa, Okla., when a dilapidated stand went down with baseball fans. Later the football rooters at Greencastle, Ind., were too enthusiastic as the rival teams trotted onto the field and the swaying of the crowd is said to have been the immediate cause of the collapse of a grandstand which injured 100 persons. Admonitions cannot be given too often regarding the dangers from deterioration, inadequate strength or lack of rigidity in structures stressed to the limit but a few times a year. Careful inspection by competent specialists is necessary on temporary as well as on permanent structures, while temporary stands, the failure record teaches, require especially careful examination and checking before their use is allowed. This is a subject in which local engineering societies might well interest themselves, especially since regular inspection by building departments often does not include stands.

Engineers on Service Boards In last week's issue of the Engineering Record mention was made editorially of the visit of a committee of the American Institute of Consulting Engineers to the new Governor of New York, to urge upon him the appointment of engineers to the Public Service Commissions. On page 545 of this issue will be found the argument made. Simple and direct, it is well calculated to bring home to the thoughtful the great advantage which must accrue to the public from the appointment of engineers to such commissions. Their counsel, having full weight as members and not as employees of the commissions, will throw into proper relief the engineering factors which should control important situations. The citation of one instance, in connection with the New York subways, shows how the planning to which the engineer is accustomed has been neglected. It is not amiss to repeat here what was said last week—that work such as the New York society is doing awaits engineering societies the country over. Many vacancies on public bodies will be filled Jan. 1. Now is the time to act.

Independent Power for Valves The failure of power for operating the valves was responsible, in the last analysis, for the havoc wrought at the Pioneer power station of the Utah Light & Railway Company, at Ogden, Utah, on Oct. 26. The accidental closing of a control switch, as recounted in the Current News Section of this journal last week, opened a 24-in. valve leading to a partly dismantled turbine. The flow cut off the power from the motor, and the valve, after being closed by hand, gave way under the heavy water hammer. The next valve above could be closed but half way, due to a break in the seat, passing the burden to a 72-in. hydraulically operated valve, which closed all but 12 in., when the pressure was balanced. Finally the valve at the head of the 6000-ft. wood-stave pipe had to be closed, and since power was off it had to be worked by hand, requiring six men two and one-half hours to get it down. Had there been an independent source of power, from another station or from storage batteries, and had the hydraulically equipped 72-in. valve been motor driven, much of the damage would have been avoided. Hand-drive is a poor dependence in an emergency, and motor-drive with sole dependence on the station generators is likely to fail at critical times. The collapse of the pipe line due to vacuum behind the receding water column also carries its lesson—that careful consideration must be given to the provision of air vents in penstock lines.

Motor Trucks and Bridges The collapse on Nov. 6 near South Royalton, Vt., of a section of a bridge floor under a heavily loaded motor truck, with the resulting death of the owner of the truck, is a warning which the New England road authorities should take to heart. Traction engines which test highway bridges so thoroughly in the Central States are little used in New England, and road rollers and interurban cars are not likely to come on these structures until an engineer or contractor has ascertained their ability to carry such weights. So the old bridges, until within a year or so, have never been tested by anything heavier than the loaded farm wagons for which they were designed. With the advent of the motor truck very heavy loads came unexpectedly on these light bridges. The truck that went through the Vermont bridge was reported to weigh 3 tons and to have had a 7-ton load, and was making a run to determine the practicability of using such trucks for moving furniture long distances. This business is developing rapidly in New England, and will impose dangerous loads on many old bridges. These loads are but the precursors of the road roller and probably of the traction engine, for this section will not long remain as unprogressive agriculturally as it is to-day. The old bridges have been satisfactory for so many years that there is an unwarranted but deep-seated local belief in their adequacy. They are dangerous for heavy loads, however, and the States would do well to arrange for such an inspection of them, or of those on important routes, as the State of New York conducted a little more than twenty years ago, when the condition of the railway bridges within its boundaries was subject to serious question. Moreover, the rapid improvement of roads in that section will increase the truck traffic and expose a great number of structures to loads they were not designed to carry.

Trainmen Win Wage Advance There is much food for reflection in the report of the board of arbitration, which on Nov. 10, under the Newlands Act, granted in part the demands of the railroad conductors and trainmen. The board was composed of Seth Low and Dr. John H. Finley, representing the public; W. W. Atterbury and A. H. Smith, representing the railroads, and L. E. Sheppard and D. L. Cease, representing the brotherhoods. The award, representing a 7 per cent increase, will amount to about $6,000,000 per annum—about one-third of the demands; the men lost in their request for extra pay for overtime work and for service on trains with two or four locomotives. The 7 per cent increase puts the wages on the same basis as in the South, but still lower than in the West. The cost of living, which the board has found has risen 7 per cent since the wage adjustment in 1910, may also have had an influence on the result. Extra pay for overtime was denied because the railroads cannot prevent delays, while higher rates on "double-headed" trains were refused because increased productiveness of equipment imposd little or no additional burdens on the men. The guiding principle in making the award was that the wages should be determined solely on their adequacy from the standpoint of the men. In fact, the report goes so far as to say that the board could not be influenced by the dilemma in which railroads find themselves because of the inability to charge higher rates. They intimate plainly that they favor an increase in freight rates, not only that the railroads may be able to pay higher wages, but also that they may on an increasing scale provide equipment that will tend to greater safety. To the contention that under the "full-crew" laws the extra men should get lower pay, the board replies that it is "not its function to correct mistakes of the legislature, if such mistakes have been made." From these positions of the board one conclusion seems inevitable—that before long all matters relating to the railways of the country must be placed under the jurisdiction of one body, the Interstate Commerce Commission. When a board without authority to increase rates can grant a wage increase while intimating that it has disregarded the railroads' ability to pay it, and when further it admits that part of its award may be unjust because legislatures have made mistakes, there seems no escape from the conclusion that some one body must control all these factors if the railroads of the country are to have even a fighting chance.

Tempting the Fates The design of a sewerage system is commonly looked upon by the uninitiated as a very simple problem. Nothing seems easier than to lay a lot of pipe, connect laterals with main sewers and lead all to convenient outfalls. Those, however, who have burned the midnight oil in trying to design a layout with proper grades know that the work is not for the tyro. Moreover, the problem does not begin and end at the drafting board. The search of records and the discovery of subsurface conditions are necessary preliminaries to intelligent procedure. Then, too, there is no neater problem in hydraulics than to determine the runoff it is advisable to care for. That these facts are not well understood by many intrusted with the engagement of engineers to design sewerage systems is evident from examination of existing works. Sewers are found to run uphill, some are too small for reasonable future use, others so large and flat as to be elongated cesspools between storms. In this connection Peoria, Ill., has recently come into the limelight and is now tempting the fates by accepting sewer designs at a figure far below that which competent engineers have found to be the necessary minimum. The work consists of the design of a sewerage system costing somewhere between $400,000 and $500,000. It is understood that plans, estimates and report are to cost the city $350, while, if the work goes ahead, completion of details, preparation of specifications, attending hearings and lettings and giving counsel up to the time of signing the contracts are to cost $1200 additional. In other words, the preliminary work is to be done for less than one-tenth of 1 per cent of the cost and the later work for three-tenths of 1 per cent additional —in all for less than half of 1 per cent, as against at least 2½ per cent which an engineer of standing would find it necessary to charge. If Peoria believes it can get something for nothing it is in a way either to add enormously to its experience account or to do that which, proverbially, is impossible—have its belief substantiated. Even a chainman can make rough figures to prove that adequate surveys, borings and maps cannot be made with decent surveying talent for the $350 fee covering the preliminary work. Even less is it possible for the additional $1200 to get engineering ability equal to the detailing of such a system, the writing of specifications and the giving of competent advice during the stressing times preceding the signing of the contract. If not too late, it is time for Peoria to halt and take counsel. There is danger ahead.

An Unsatisfactory Report

There has been much controversy regarding the cost of maintaining concrete roads, particularly as to those in Wayne County, Michigan, on which, it was claimed, only $300 had been spent up to last winter. When it is remembered that some of these roads had been down since 1909 and that there were about 22 miles at least a year old, this is a remarkable record. The correctness of the costs has, however, been questioned. It was hoped, therefore, that the seventh annual report of the County Road Commissioners would shed light on the subject. The report, covering the period from Oct. 1, 1912, to Sept. 30, 1913, has now been issued. It is disappointing. An impartial reader, knowing the controversy, cannot but feel that the issue has been deliberately dodged. The county has, through its representatives, invited attention to its work. It owes to those who have accepted the invitation a frank and full disclosure of all the facts; and certainly in highway building, particularly in the present state of the art, the facts that a highway official or an engineer wants are as much in the account books as in those elements which can be seen on the ground.

The report is deficient, first, in its failure to present a full record of maintenance costs and, secondly, in omitting the mileage of new roads constructed, so that it is impossible to figure their unit cost. The first deficiency is all the more surprising because details as to expenditures are given on new construction, though not in a form reducible to a "per mile basis." As to the second deficiency, it may be noted that in previous reports the mileage of each new section was given in connection with the costs.

The only figure given on the maintenance of concrete roads is the total cost, $1450—for tarring all longitudinal and transverse cracks. There is no allocation between labor and materials, nor is it stated whether this sum includes the cost of filling holes. Presumably, however, it does. Moreover, while resurfacing might well be carried separately on the books, its cost must be known in determining the value of concrete roads. No data are given on this head.

The figure quoted, $1450, indicates a maintenance cost, for 60 miles of road, of $24 per mile per annum, exclusive of work on shoulders, ditches and culverts. This is exceedingly low, and naturally will attract attention. The previous maintenance figure, $300, for all the roads for their whole life up to the end of 1912 and the statements of low up-keep costs resulted, before the appearance of this report, in estimates quite at variance with the figures now announced. For example, Mr. Paul E. Green, reporting on concrete roads for two suburbs of Chicago, estimated the maintenance costs for 1913 at $2378 for cracks alone, based on his observations of the work of a tarring gang. He makes an additional allowance of $820 for filling holes, but this is for the two years 1912 and 1913. Assuming that half of this is chargeable to 1913, the maintenance cost would be about twice what is indicated in the report.

If, now, the cost of the resurfacing in 1913, estimated by Mr. Green to be about $1713, be spread over the 60 miles, there will be an additional "per-mile" charge of about $30—a total of, approximately, $78 per mile per annum. While there is good reason for the contention that the later roads will not need resurfacing as early as did the first, if at all, proper deductions from the Wayne County work require that these costs be considered.

Furthermore, since Mr. Green gives an analysis of his figures they are as likely to be accepted, particularly by those "with an axe to grind," as is the single lump sum given in the report.

It is apparent, therefore, that the failure of the report to meet the issue by detailed figures leaves engineers at sea as to the merits of the controversy. Whether the total given in the report, supplemented by estimates an engineer will make for himself, or even Mr. Green's figures, would tend to discourage the construction of concrete roads depends much on what one assumes to be necessary in a pavement designed for fairly heavy traffic, and upon the life which experience and judgment indicate should be allowed for different pavements. A full report, however, would have put engineers nearer the solution of the problem.

Flattening the Efficiency Curve

An interesting feature of efficiency studies in connection with the work of industrial organizations is the determination of limiting times and outputs outside of which the most economical service disappears. The efficiency curve of a steam turbine, of a reciprocating engine, electric generator, motor or designing organization invariably has the characteristic of remaining substantially constant between certain loads, while above and below these limits satisfactory and equally economical operation cannot be had. A boiler factory or a rail mill yields its product at the lowest unit cost only inside a certain range of outputs and a specific plant for field work likewise exacts its toll of increased unit expense if its owner operates it far below its capacity or forces it to an accomplishment outside that which reasonably may be demanded. Engineers engaged in betterment work meet this condition constantly, and there is no greater test of designing and administrative ability than the speed with which a plant or organization prepared to meet changing requirements attains and then holds its maximum efficiency within a few per cent of its normal best.

It is one problem to design a great railroad classification yard, repair shop or power plant to perform its work most efficiently within a narrow set of demands and another to plan and assemble such an installation in a manner which yields highly efficient service soon after the physical equipment is ready for duty. The necessity of building for the future is often a very serious handicap to the engineer seeking highly efficient operation under present conditions, and there is no question that vast sums of money are yearly lost in cases where a policy of waiting for business to grow up to newly established facilities is permitted without vigorous effort to avoid its apparently inevitable wastes. Over and over again a concern builds an important extension to its plant, invests heavily in organization or machine capacity which the near future will surely demand and then is grievously disappointed because the first six months' operating records fail to show even an approximation to the economies promised by the accepted estimates for full-load performance. The sight of equipment standing in reserve against emergencies and bearing its burden of fixed charges is often unwelcome to the manager of such a property, but it is as nothing to the thorn in the flesh of rows of machines, lines of drafting tables and groups of motor trucks commandeered for service before their full duty is required. The avoidance of as much of this waste as possible is a supremely important problem.

Here is where the advice of the expert consulting engineer specializing in this or that field becomes immensely valuable to the organization making use of his services. In a representative case where a new industrial plant was required, the heads of the various departments were all invited to submit their recommendations as to floor space and arrangement. When the figures in the different reports were added, it appeared that 450,000 sq. ft. were required to house the several departments. When the reports were analyzed by an industrial engineer who was an old hand at coordinating inter-departmental schemes it was found that the company's work could be handled with the greatest advantage on 225,000 sq. ft. of floor area. The installation was made on this basis, with the result that every department, despite the 450,000 sq. ft. estimated as necessary received a substantial increase in space over that which had formerly limited its efficiency; lost motion between related departments handling work in sequence was practically eliminated; and even then a liberal allowance for future growth was arranged for in the plans, partly by roofing over more space than could at once be utilized and, in the main, by designing one and two-story structures for later one or two-story additions. Almost immediately after the various departments were transferred from their old to their new locations the improved design of the structures and facilities on the latter began to show itself in reduced delays and a greater volume of output in proportion to the payroll.

To extend the range of maximum efficiency in newly established plants and organizations it should be clear that a niggardly policy in regard to preliminary investigations will defeat its own ends. Enough money must be expended to enable engineers of the proper training and judgment to take time to work out the economic limits of various equipment combinations and investments. A sense of proportion is everything in tasks of this character. If the betterment scheme calls for the use of a large number of motor trucks to handle a volume of business rapidly growing but still insufficient to demand the intensive use of such machines, it is plain enough to the expert that the orders for such equipment should be distributed over a protracted period; while, on the other hand, it will very likely pay to provide the ultimate garage facilities at the beginning, including the complete wiring for local lighting and power and the installation of the maximum number of charging plugs and controlling switches in case the fleet is of the electric type. Anticipation of the growth of business by graphic and arithmetical studies, the avoidance of penny-foolish "economies" along the line of refusing to install inexpensive auxiliary equipment until its service becomes imperative, strict attention to the analysis of operating records during transition periods and greater care in using equipment suited to the existing loads where the machinery is well subdivided will go a long way toward flattening the efficiency curve in the region of its maximum values and toward forcing the investment to yield an earlier and a better return.

The Rocks Ahead of the Continuation School

Reference has already been made in these columns to some of the differences of opinion which have been brought forth by recent discussion of the continuation school. This movement has found favor with manufacturers and workmen, but the teachers either fail to appreciate the gravity of the problem which the continuation school aims to solve or else believe that their methods offer a solution. Whichever may be the case, fair-minded men who inquire into the conditions will find that the pedagogue's solution is inadequate and that a strong stand will soon be necessary in order that pedagogical ideals may not misdirect and nullify a movement which, under proper guidance, has been very successful abroad.

The educators advocate "trade" schools so strongly that one must construe their stand as a belief that these schools can really solve the problem. But what does the record show? For thirty years trade schools have been urged, yet 50 per cent of our children still leave school after the sixth grade and get no further training. Evening classes are doing some good, but the number which use them are exceedingly small. Yet in the face of these conditions the demand for trade schools goes on. Only two weeks ago the Superintendent of Public Schools of New York berated the Board of Estimate for refusing to appropriate money for such institutions. His theory is correct—that means should be provided for giving vocational training to the 40,000 children who annually leave New York's schools at the age of 14; but his remedy is wrong. The thousands of dollars appropriated for his plans would go to educate only a few, neglecting those thousands whom necessity forces to earn their living, no matter how alluring the trade courses offered.

It must not be assumed that criticism is here leveled against the trade school as such. It does a good work so far as it goes; but it educates a hundred where the same amount spent on the continuation plan would help to prepare 2000 or 2500 for better citizenship. Records of thirteen trade schools in the United States show that the cost per pupil is about $250 per annum, exclusive of cost of plant. Contrast with this the record of Wisconsin's first year with the continuation school—a cost per pupil of only $10. In that State the enrollment for the first full year was 15,000, and this without a penny's outlay in new buildings, and only small expenditure for equipment. This year 25,000 pupils at least are expected. The employers of the State are warm in their praise of the movement, and though there was opposition in some quarters at the start, it melted away when the methods and aims were clearly comprehended.

One thing that Wisconsin's experience should teach is that large expenditure—the common American method of measuring success—is not necessary. Employers have given aid with a will, and competent teachers, not pedagogues but men and women from the stores and the shops, have not been difficult to find.

As to the control of these schools, also, there is controversy. The educators demand that it shall be in their hands, conceding that boards of employers and employees might have purely advisory functions. That such control will not result in the heartiest co-operation of employers is patent, and that it may result in completely subverting the aims of the schools is evident from the records of the trade schools and evening classes. In Wisconsin the regular boards of education have no authority over the continuation school. A separate board is constituted, consisting of the city superintendent of schools, two employers and two employees, the superintendent affording a connection with the regular school system. Likewise, the State board consists of educators, employers and employees, three from each class. This method of control has, without doubt, been largely responsible for the excellent co-operation secured.

It is well for the educated and influential members of every community to have in mind the facts here emphasized, for there are signs that the country is waking up to the need for continuation schools. Already Massachusetts, Connecticut and Indiana are considering legislation which, there is reason to believe, will find its way into the statute books during the coming winter. Continuation schools must be managed not by pedagogues but by them jointly with employees and employers, the two latter classes, as in Germany, forming a majority of the board. Any other arrangement will prevent the schools from working in close touch and sympathy with the industries and commercial life and seems foredoomed to partial or total failure.

Recent Structural Progress in Power Distribution

Coincident with the rapid development of electric-power transmission have come new standards as to related structural matters. In work of large magnitude the designs of one set of experts may have to be checked by specialists in several lines, as in the case of steel towers for long spans, which involve heavy investment costs and great service reliability. The electrical engineer may design such a tower with detailed service requirements in mind, but the structural engineer may properly be given a free hand in the final makeup of drawings and specifications. In the less spectacular, but just as important, field of power distribution the results of joint engineering effort are equally satisfactory.

Structural progress in power distribution shows itself to better advantage in the handling of high-voltage circuits and apparatus than perhaps anywhere else. The open-air type of substation familiar in the dry climate of the Rocky Mountain tableland is pushing eastward. In Massachusetts alone, where but a few years ago the highest electrical pressure in use on outdoor lines was 13,200 volts, two substations capable of handling energy at nine times this potential are under construction, and a third, designed for a considerably lower voltage, will shortly be completed by an interurban railway company. Modern methods of unit insulation, combined with the use of structural steel towers and supporting bridges for outdoor busbars and disconnecting switches, appear more than equal to overcoming even the boisterous and variable climatic conditions of the Atlantic Coast. In work of this sort the transformer units needed and the oil circuit-breaker equipment are of great bulk, demanding a wholesome amount of elbow room when in operation, while the exposed conductors force the designer to grant them clearance spaces which have literally revolutionized the arrangement of apparatus. Economy in building construction and the requirements of safe operation are jointly working to keep extra-high-tension equipment of all kinds in the open air. The mounting of such apparatus, its reasonable protection from accumulated water, accessibility for repairs and adjustments, the safeguarding of the equipment against abnormal wind and sleet strains, provision for withdrawal of heavy unit sections, consideration of bending and twisting stresses, expansion and contraction, and in some cases the supply of circulating water of the requisite quality—all need competent engineering treatment. This is fortunately being accorded in most cases where power is distributed from ultra-dangerous lines, and the civil engineer is collaborating more and more frequently in the structural side of high-tension plants.

It is noteworthy that even in cases where moderately high voltages are being used indoors, say under 60,000, increased skill in the disposition of equipment is apparent. One constantly finds lightning arresters of the electrolytic type installed on the roof, with short taps to the horn gaps from incoming line conductors dead-ended at multiple-disc strain insulators attached to steel or pipe-frame supports. Special thought has been given to the design and construction of entrance cones and bushings, thoroughly waterproofed against creeping dampness around the roof surface and entering leads. The mounting of insulators on special steel framing or pipe structures crossing the building far above the tops of transformers and switches is coming into greater favor; and by the use of copper tubing and pipe fittings of the same material where the direction of lines changes a rigid and thoroughly satisfactory interior wiring layout is secured. A striking refinement in the arrangement of the ordinary simple disconnecting knife switches used in breaking phases in lines and on each side of apparatus subject to overhauling lies in the mounting of this equipment on multiple petticoat insulators fastened on horizontal axes to box framing of fabricated steel members carried across the station and supported at the ends and at intermediate points by pipe framing and I-beams of small size.

More and more the supporting of high-voltage apparatus on wooden baseboards is passing away, and it is a far cry from the plant with disconnecting switches mounted near the floor and behind the switchboard to the present installations in which busbars are carried either on insulators supported on structural steel or pipe framing or else housed in concrete compartments free from dust and moisture, with wired glass inspection windows and segregated switches controlled from an operating center, to which only low-voltage conduit-inclosed wires are run, in which clearance receives its due as a factor in safe and flexible operation, and where the mechanical breakage of conductors is guarded against by all the resources of modern constructive ability.

Failure of Groined Arches at Baltimore's New Water-Filtration Plant

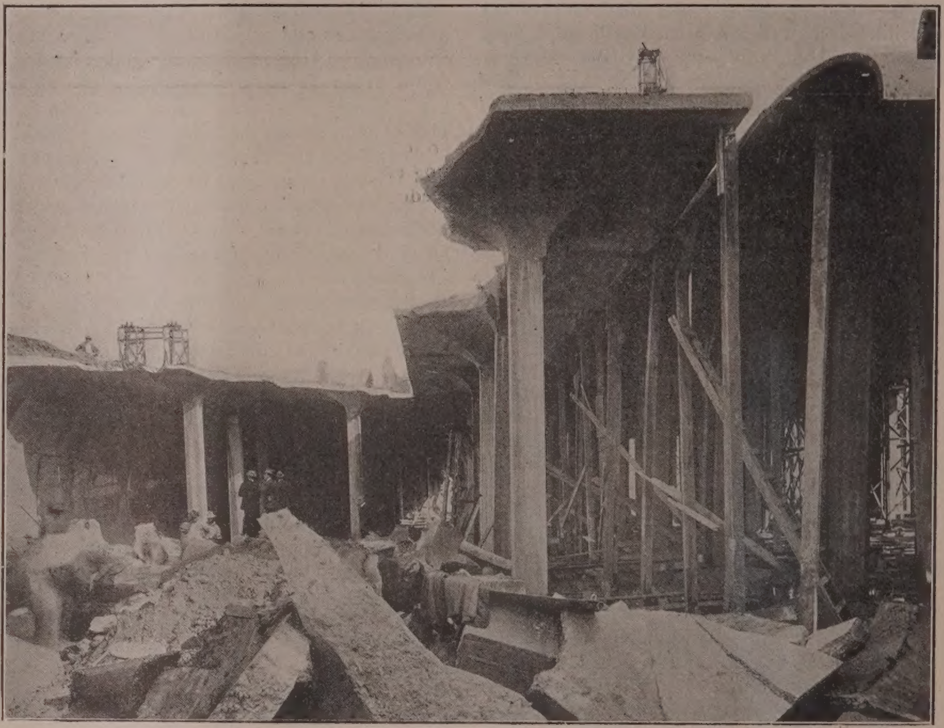
Collapse Was Caused by Premature Loading of Concrete Arches with Earthfill without Provision for Taking Up Thrusts, Groins Acting as Cantilevers

By James W. Armstrong, Engineer, Filtration Division, City Water Department

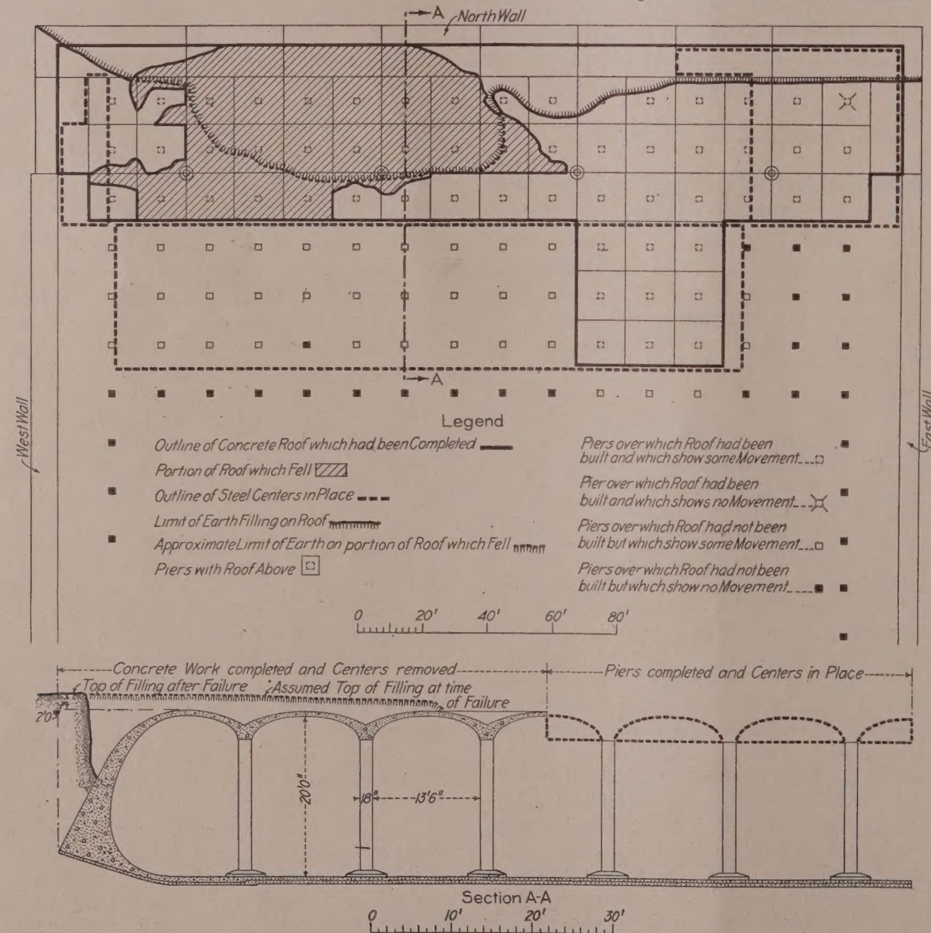
The failure on Oct. 20 of a portion of the groined arches of one of the filtered-water reservoirs at Baltimore, as reported in the Current News Section of the Engineering Record of Oct. 25, has attracted considerable attention, and in order to secure an unbiased opinion of the merits of the design, the cause of the failure, and the best method of remedying the trouble, the Baltimore Water Board authorized Mr. Ezra B. Whitman, water engineer, to secure the advice of an engineer experienced in groined-arch construction to report on the situation. Mr. John H. Gregory, of the firm of Hering & Gregory, consulting engineers, of New York City, was selected to investigate the failure. His report, submitted last week, ascribed the collapse to the premature loading of the concrete barrel arches and groined arches with earthfill. Excerpts from the report are given in the latter part of this article.

GROINED-ARCH DETAILS

The groined arches which fell were to form a portion of the cover over one of the filtered-water reservoirs which are being constructed in connection with the filtration plant at Lake Montebello. Each of the twin reservoirs measures 241 ft. x 258 ft. 6 in., inside dimensions. They are separated by a reinforced-concrete division wall, 2 ft. 3 in. thick at the floor and 18 in. thick at a point 17 ft. above the floor. The thrust at the top of the wall is transmitted through a barrel arch to the groined arches beyond. The space between the barrel arches over the division wall and the depressions in the groins over the columns for one span on each side of the wall are filled with concrete. The reinforcement of the division wall is thoroughly anchored to the arches above.



Collapsed Section of Groined-Arch Vaulting over Filtered-Water Reservoir


A
North Wall
A
West Wall
East Wall
Legend
Outline of Concrete Roof which had been Completed
Portion of Roof which Fell
Outline of Steel Centers in Place
Limit of Earth Filling on Roof
Approximate Limit of Earth on portion of Roof which Fell
Piers with Roof Above
Piers over which Roof had been built and which show some Movement
Pier over which Roof had been built and which shows no Movement
Piers over which Roof had not been built but which show some Movement
Piers over which Roof had not been built but which show no Movement
0 20' 40' 60' 80'
Concrete Work completed and Centers removed
Piers completed and Centers in Place
Top of Filling after Failure
Assumed Top of Filling at time of Failure
2'0"
20'0"
18"
13'6"
Section A-A
0 10' 20' 30'

Conditions at Filtered-Water Reservoir before and after Failure

Each reservoir has a capacity of about 7,750,000 gal., or a combined capacity of 15,000,000 gal. The floor is composed of two layers, each 4 in. thick, laid in 15-ft. squares. The 5-ft. square reinforced-column bases were placed upon the center of the bottom floor blocks. The columns are 18 in. square and 16 ft. 2 in. high to the spring line of the groined arches. The groined arches have a clear span of 13 ft. 6 in., a rise of 3 ft., a thickness at the crown of 6 in. and a depression over the columns of 21 in. The under side of the arches is semi-elliptical in form and the outside parabolic. The outer wall is of an arched section, similar to that sometimes used in large aqueducts and is so designed that the thrust from the groins and earth is carried down through the arch to the base. The earth cover is 2 ft. 3 in. thick on the east side, sloping to 1 ft. 9 in. on the west side. At the time of the accident the earth embankment along the north wall was made almost to a finished grade line at the point opposite the failure, and a thin covering of earth extended in an irregular line over the first two tiers of groins that failed, barely touching in some places the third or outer tier.

The steel forms were in place opposite the point of failure for three groins in advance of the concrete. Seventeen groins collapsed and a number of others were so badly injured that it will be necessary to tear them down. Most of the others were tipped more or less to the southward, the columns showing a slight crack at the base on the north side. The concrete in the groins was composed of 1 volume of Tidewater cement, 2½ volumes of sand and 5 volumes of gravel; all other concrete was mixed in a 1:2:4 ratio. The earth upon which the reservoir was built was very firm. The sides of the excavation were cut vertically in all cases in order to permit the passage of the traveler from the steel wall forms. In some cases the vertical sides of the

DATA RELATING TO GROINED ARCHES WHICH HAVE BEEN BUILT IN THE UNITED STATES AND CANADA

Compiled by John H. Gregory

Date completed	Location	Structure	Total area, acres	Depth earth cover, ft.	Concrete mixture	GROINED ARCHES Span, ft. and in.	Rise, ft. and in.	Crown thickness, in.	PIERS Size, in.	Depression above, in.
1903	Yonkers, N. Y.	Filt. water reservoir	0.06	4	1:2.9:5	10–0	1–6	6	16¾x16¾	9¾
1903	Watertown, N. Y.	Coag. basin and reser.	0.40	2	1:2.9:5	10–0	1–6	6	18x18	10
1909	Providence, R. I.	Filters	10.00	2	1:2½:5	10–3	2–6	6	20x20	15
1903	Ithaca, N. Y.	Coag. basin and f. w. res.	0.25	2	1:2½:4½	10–6	1–6	6	18x18	10½
1912	Grand Rapids, Mich.	F.W. res. under mech. filt.	0.22	None	1:2:4	10–6x10–4	2–9	9	24x24	None
1909	New Orleans, La.	Filt. water reservoir	3.74	1	1:2½:5½	10–8	2–6	6	16x16	....
1907	Cincinnati, Ohio	Supports under mech. filt.	1.05	None	1:2½:5	11–0x9–5¾	2–6	8	21x21	None
1909	Springfield, Mass.	Filters	3.12	2	1:3.1:5.3	11–4	2–0	6	20x20	15
1911	Toronto, Ont.	Filtered water res.	2.23	2	1:2½:4½	11–4	2–0	6	20x20	14
1911	Toronto, Ont.	Filters	10.08	2	1:2½:4½	11–4	2–0	6	20x20	14
1910*	Owen Sound, Ont.	Filters	0.49	....	....	11–6	2–6	6	18x18	14
1905	New Milford, N. J.	F.W. res. under mech. filt.	0.25	None	1:2½:5	11–8x9–8	2–6	8	24x24	None
1903	Washington, D. C.	Filters	5.18	2	1:3.1:5.3	11–10	2–6	6	22x22	17
1908	Columbus, Ohio	F.W. res. under mech. filt.	0.53	None	1:2½:5½	11–10x9–8	2–6	8	24x24	None
1913	Minneapolis, Minn.	F.W. res. under mech. filt.	0.38	None	1:2:4	11–10x10–10½	3–0	9	26x26	None
1899	Albany, N. Y.	Filters	5.74	2	1:3:5	11–11	2–6	6	21x21	6
1897	Wellesley, Mass.	Reservoir	0.12	2	1:2½:4½	12–0	2–6	6	24x24	None
1900	Superior, Wis.	Filters and reservoir	0.59	2	1:3:5	12–0	2–6	6	20x20	6
1903	Brookline, Mass.	Reservoir	1.4	1.75	1:2:4	12–0	2–6	6	20x20	None
1910	Wilmington, Del.	F.W. res. under final filt.	2.11	None	1:3:5	12–0	3–0	9	24x24	None
1905	New Milford, N. J.	F.W. res. under bldg.	0.10	None	1:2½:5	12–0x11–8	2–6	8	24x24	None
1913*	Montreal, P. Q.	F.W. res. under pre-filt.	0.65	None	1:2½:5	12–0x10–3	3–0	8	30x30	None
1913*	Montreal, P. Q.	F.W. res. under future pre-f.	1.35	3	1:2½:5	12–0x10–3	3–0	8	30x30	None
1913*	Montreal, P. Q.	Filtered water reservoir.	0.23	3	1:2½:5	12–0x10–3	3–0	8	30x30	21
1913*	Montreal, P. Q.	Supports under pre-filt.	0.53	None	1:2½:5	12–0x10–3	3–0	9	30x30	None
1899	Clinton, Mass.	Reservoir	0.18	4.5	1:2½:4	12–⅜	2–6	12	30x30 24x24	None
1903	Washington, D. C.	Filters	23.72	2	1:3.1:5.3	12–2	2–6	6	22x22	17
1909	Yonkers, N. Y.	Filters	1.55	2	1:3:5	12–2	2–6	6	22x22	
1899	Concord, Mass.	Reservoir	0.06	2.5	1:2:5	12–9	3–0	6	24x24	None
1912	Roland Park, Md.	Reservoir	0.34	2	1:2½:5½	13–0	2–8	6	20x20	18
1907	Philadelphia, Pa., Torresdale	Filters	16.50	2	1:3:5	13–2	3–0	6	22x22	21
1907	Lawrence, Mass.	Filter	0.74	3	1:3:5	13–2	2–9	6	22x22	20
1908	Pittsburgh, Pa.	Filters	46.0	3	1:3:5	13–2	3–0	6	22x22	21
1910	Pittsburgh, Pa.	Filters (Extension)	10.0	2.3	1:3:5	13–2	3–0	6	20 diam.	21
1904	Philadelphia, Pa., Belmont	Filters	13.23	2	1:3:5	13–5	3–0	6	22x22	21
1913*	Baltimore, Md.	Filtered water res.	2.78	1.75 to 2.3	1:2½:5	13–6	3–0	6	18x18	21
1912	Philadelphia, Pa., Queen Lane	F.W. res. under fin. filt.	17.2	None	1:2½:5	13–6	3–9	10	30x30	None
1902	Natick, Mass.	Reservoir	1.02	2	1:2½:4½	13–6	2–9	6	20x20	None
1912	Grand Rapids, Mich.	Filtered water res.	0.57	1.5	1:2:4	13–10	3–0	6	14x14	22
1902	Philadelphia, Pa., Lower Roxborough	Filters	2.69	2	1:3:5	14–0	3–0	6	22x22	21
1902	Lower Roxborough	Filtered water res.	0.70	2	1:3:5	14–0	3–0	6	22x22	21
1903	Upper Roxborough	Filters	5.58	2	1:3:5	14–0	3–0	6	22x22	21
1903	Upper Roxborough	Filtered water res.	1.74	2	1:3:5	14–0	3–0	6	22x22	21
1904	Belmont	Filtered water res.	3.48	2	1:3:5	14–0	3–0	6	22x22	21
1907	Torresdale	Filters	24.75	2	1:3:5	14–0	3–0	6	22x22	21
1907	Torresdale	Filters (Extension)	7.50	2	1:3:5	14–0	3–0	6	22x22	21
1907	Torresdale	Filtered water res.	10.53	2 to 2.8	1:3:5	14–0	3–0	6	22x22	21
1902	Milford, Mass.	Filters	0.25	1.5	1:2½:5 1:3:5	14–0	3–0	6	24x24	18
1909	Springfield, Mass.	Filtered water res.	2.12	2	1:3.1:5.3	14–0	2–9	6	24x24	18
1908	Columbus, Ohio	F.W. res. (Part of)	1.63	2.25	1:2½:5½	15–2	3–2	6	20x20	23
1905	Washington, D. C.	Filtered water res.	2.28	2	1:3.1:5.3	15–6	3–6	6	30x30	24¾
1895	Ashland, Wis.	Filters	0.50	2	1:2½:5	15–9	3–6	6	28x23	None
1908	Pittsburgh, Pa.	Filtered water res.	6.36	3	1:3:5	15–9	4–0	6	27 diam.	26
1896	Somersworth, N. H.	Filters	0.50	2.5	1:2½:5	16–0	4–0	6	34½x34	None
1913	Minneapolis, Minn.	Filtered water res.	7.65	2	1:2:4	16–4	3–6	6	20x20	24
1913*	Montreal, P. Q.	Final filters	6.9	3	1:2½:5	17–0	4–3	6	24x24	24

*Under construction.

excavation stood for several months without showing signs of failure. The concrete in the groins from which the centers had been struck was from 16 to 55 days old at the time of the accident.

EXTENT OF BREAK

The accompanying diagram shows clearly the extent of the break, the line of earth to the top of the groins, and the position of steel forms in place at the time of the accident. It has been decided to remove all groins that are so damaged as to be dangerous. Those which are cracked in a lesser degree are to be repaired by covering the entire area of the groins with concrete, completely filling the depressions over the columns and reinforcing with steel bars in both directions. Where the columns have been tipped slightly the small cracks at the base will be grouted with cement.

MR. GREGORY'S FINDINGS

Without attempting to give a résumé of Mr. Gregory's report such portions of it are quoted below as show his conclusions regarding the most interesting phases of the trouble.

"An investigation has been made to determine the amount of thrust in the arches under different conditions of loading from which it has been found that the compressive stresses in the concrete are within the limits which can be allowed on concrete of the character used in the construction of the work. Similarly, the loads on the piers and on the foundations are within safe limits. Groined arches of the type being built at Baltimore have been used extensively in the United States in the last ten to fifteen years for covering reservoirs and slow-sand filters. . . .

"Considering, then, not only the studies which have been made, but also the large amount of similar work actually constructed and in service elsewhere, it is my opinion that the Baltimore groined arches, if built of the materials and in accordance with the requirements specified, are safe and suitable for the purpose for which they were designed. I see no reason for making any changes in the design of the groined arches and I recommend that the work be constructed in accordance with the present design.

"The concrete in that portion of the roof which fell, as well as in that portion of the roof still standing but which has been damaged to a greater or less degree and from which the centers had been removed, was all placed between Aug. 26 and Sept. 26. During this period the records of the U. S. Weather Bureau show that there was no freezing weather, and hence the concrete could not have been affected by the action of frost. From my examination of the concrete, not only in that portion of the roof which fell but in that portion still standing, and also from investigation of the conditions under which the work was built, I am of the opinion that the failure was not due to poor concrete.

"The effect of the earth filling on the roof was to produce a thrust not only in the barrel arch of the north wall but also in the groined arches. No provision was made for taking up the thrust at the southerly end of the groined arches. The effect of the unbalanced thrust was, therefore, to tend to overturn the groins and piers in a southerly direction. The three piers with the groins and earthfill above have some stability, but their moments of stability against overturning are not sufficient to balance the overturning moment of the thrust applied at the crown of the arches.

"While the groined arches will safely carry

View along Reservoir Side Wall, Which Is of the "Aqueduct Section" Type

the earthfill if proper provision is made for taking up the thrust, they are not safe when loaded unless provision is made for taking up the thrust, for the reason that the unbalanced thrust allows the groins to act as cantilever beams supported at the center, thereby producing tension in the concrete on the upper side of the groin.

"From examination of the structure and from studies subsequently made it is my opinion that the failure was due to the premature loading of the barrel arches and groined arches with earth before provision had been made for taking up the thrust at the southern end of the groined arches, the effect of which was to cause some of the groins to fall while acting as cantilever beams and others to be overturned. When the groined arches next to the barrel arches failed the barrel arches failed, as there was nothing to support them."

Prize Design for James River Bridge at Richmond

Among the thirty-one competitive designs for the reinforced concrete bridge, 3480 ft. long and 60 ft. wide, over the James River at Ninth Street, Richmond, Va., the one submitted by Mr. B. H. Davis, Assoc. M. Am. Soc. C. E., consulting engineer, New York City, was awarded the first prize of $1,500. The second prize of $500 was awarded to Mr. Robert A. Cummings, of Pittsburgh. The new bridge will replace an old steel structure which is insufficient for the traffic between Richmond and the recently annexed town of Manchester.

For the engineers entering the competition the city engineer, Mr. Charles E. Bolling, had prepared a profile and map of the site and a typewritten sheet containing the requirements of the administrative board. Seventy copies of these blueprints and requirements were issued. It was commonly understood that the contract for the complete design would be awarded to the engineer submitting the one accepted.

After the plans had been received and each engineer had been given an opportunity personally to explain his plans, the competition was formally closed. The administrative board which examined the designs consisted of Mr. Charles E. Bolling, city engineer; Mr. J. Ambler Johnson, architect and engineer; Mr. H. P. Beck, engineer, and Mr. Carlton McCarthy, a former mayor of Richmond. The competition was closed on April 15 and the board agreed upon the prize-winning designs in July. In the architectural treatment of the prize plans Mr. Davis was assisted by Mr. Vance W. Forbert, of New York City.

Details of Winning Plans

The bridge, as designed, will have a main river span, 1940 ft. long, consisting of eleven semi-elliptical arch-rib spans, each 160 ft. long with a 40-ft. rise surmounted by segmental spandrel arches and flanked by two viaduct approaches, 690 and 850 ft. long respectively.

Each approach will have two 56-ft. arched spans and four deep, narrow girder spans of segmental form, having sufficient rise to act as an arch independent of any reinforcement or as a T-beam if considered as acting with the floor slabs. For a short distance at each end the approaches consist of retained fills. The present arch over the Southern Railway is to be extended and its parapets rebuilt to allow for the curved form of the Manchester approach. The bridge proper will be separated from its approaches by four large ornamental pylons of concrete, two at each abutment. Considerations influencing the choice of long-span arch construction were the clearance requirements at the existing steel structure, the right-of-way of the Chesapeake & Ohio Railway and the Virginia Railway & Power Company. At the same time the spans were to be of uniform length, an important feature in a multiple-arch structure.

Long-Span Arches

Each of the long-span arches is composed of two parallel arch ribs 14 ft. wide and 4½ ft. thick at the crown, spaced 20 ft. apart. The reinforcement of these ribs, though unnecessary for any of the assumed loadings, is distributed so as to be most effective in resisting internal stresses due to shrinkage and temperature stresses. Bench walls and arch ribs are connected by reinforced concrete floor beams of 20 ft. clear span. Cantilever slabs, overhanging the arch ribs 6 ft., support the balustrades and form parts of the sidewalks. The roadway is 44 ft. wide. Refuge bays or niches are provided over each pier of the entire structure. Sidewalks will be cement finished and 7 ft. in width from balustrade to curb. Balustrades and lamp posts will be reinforced concrete, and lamp brackets, fixtures and trolley-wire supports are to be of bronze. Wood block or asphalt pavement is specified for the roadway. Liberal provisions for terra cotta ducts, gas, water mains and drainage are shown in the plans. The waterproofing of the structure is taken care of in the specifications, which call for a membrane of approved quality thoroughly protected by brick or concrete.

The double-track electric railway for the interurban traffic between Petersburg and Richmond, provided for in the design, is mainly responsible for the massive nature of the proposed structure. For the sake of economy the new bridge has been designed to straddle the present structure, which with its cantilever sidewalks removed, will form an ideal construction trestle with standard gage tracks already in position for construction operations.

When the contract is executed all gas and water mains, trolley tracks and electrical wiring will be furnished and installed by the respective city departments.

Smoke Costs Pittsburgh $10,000,000 Annually

A thorough study of the financial loss attributable to the smoke nuisance has been completed in connection with the recent smoke investigation in Pittsburgh. The work was begun under the direction of Dr. C. W. A. Veditz, who was succeeded by Mr. John J. O'Connor, author of the report published recently as Bulletin 4 of the University of Pittsburgh.

In 1909 the per capita loss for Cleveland was estimated at $12, using data submitted mainly by large department stores. Assuming that Chicago was one-third cleaner, an official of that city computed an annual loss of $17,600,000; and the smoke inspector of Cincinnati, in like manner, placed Cincinnati's loss at $20 per capita annually. These estimates, however, were all based on meager data.

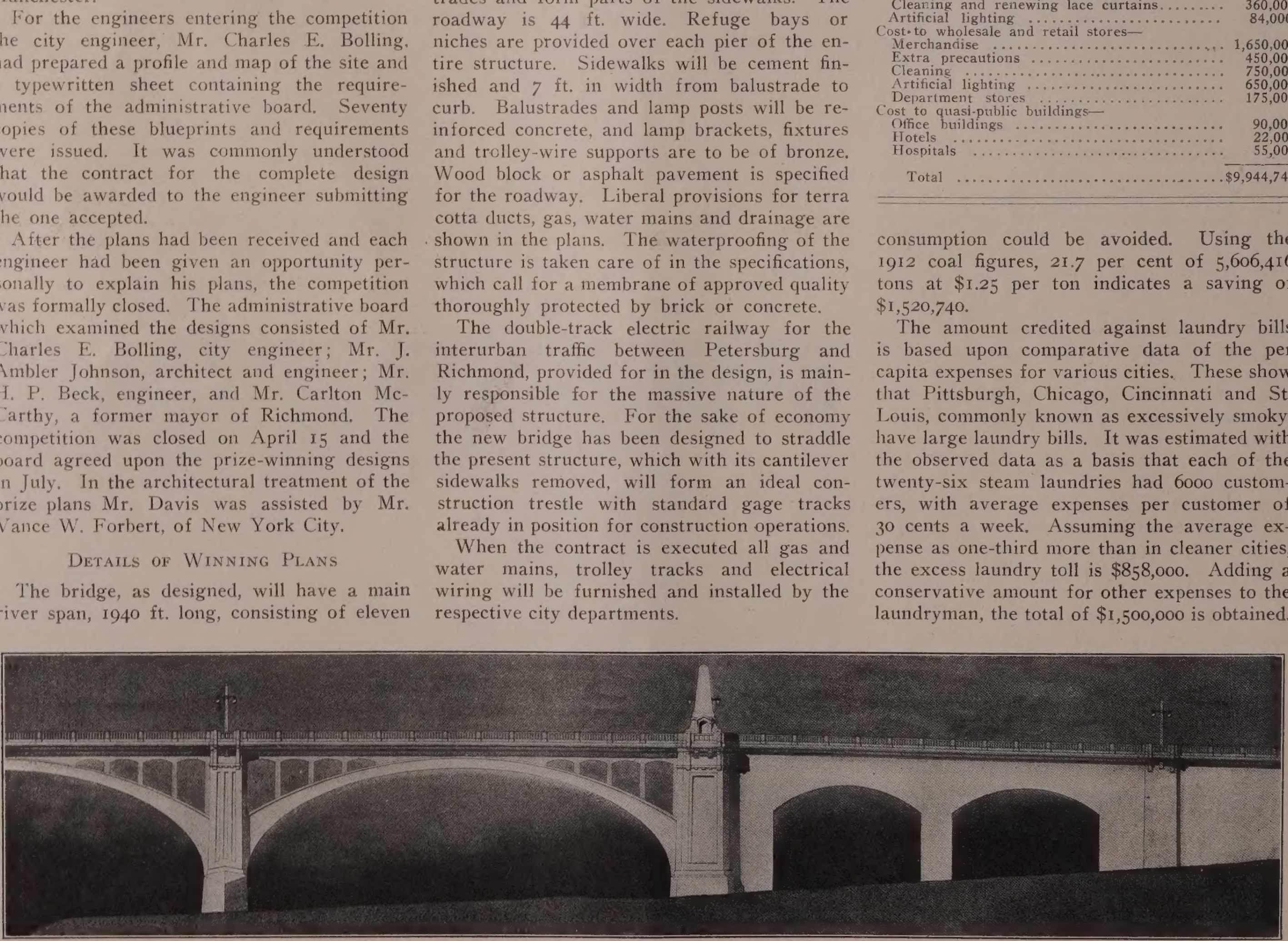
What is termed the "partial cost" of the smoke nuisance to Pittsburgh is itemized in the table below, which is taken from the report published by the University of Pittsburgh.

The engineers on the staff of the smoke-investigation commission found that, by using practicable methods of eliminating imperfect combustion, 21.7 per cent of the present fuel consumption could be avoided. Using the 1912 coal figures, 21.7 per cent of 5,606,416 tons at $1.25 per ton indicates a saving of $1,520,740.

Pittsburgh's Annual Smoke Costs Classified

Cost to the smoke maker because of imperfect combustion	$1,520,740
Cost to the individual—	
Laundry bills	1,500,000
Dry-cleaning bills	750,000
Cost to the household—	
Exterior painting	330,000
Sheet-metal work	1,008,000
Cleaning and renewing wallpaper	550,000
Cleaning and renewing lace curtains	360,000
Artificial lighting	84,000
Cost to wholesale and retail stores—	
Merchandise	1,650,000
Extra precautions	450,000
Cleaning	750,000
Artificial lighting	650,000
Department stores	175,000
Cost to quasi-public buildings—	
Office buildings	90,000
Hotels	22,000
Hospitals	55,000
Total	$9,944,740

The amount credited against laundry bills is based upon comparative data of the per capita expenses for various cities. These show that Pittsburgh, Chicago, Cincinnati and St. Louis, commonly known as excessively smoky, have large laundry bills. It was estimated with the observed data as a basis that each of the twenty-six steam laundries had 6000 customers, with average expenses per customer of 30 cents a week. Assuming the average expense as one-third more than in cleaner cities, the excess laundry toll is $858,000. Adding a conservative amount for other expenses to the laundryman, the total of $1,500,000 is obtained.



Details of Prize Design for the Ninth Street Bridge, Spanning James River at Richmond, Virginia

It was found from extensive data obtained from consumer and dry cleaner alike that dry cleaning was oftener necessary, involving a greater supply of clothing and a shorter life per garment. On a total of $1,125,000 the loss is $750,000, assuming that dry-cleaning bills were 50 per cent excessive.

Pittsburgh buildings require painting at least twice as often as those in cleaner cities, according to the report. Estimating that 50,000 of the 87,000 houses are painted every three years at a cost of $40 per house, $330,000 a year is the loss. The figures for sheet-metal roofs and gutters are obtained by assuming a renewal cost of $100 for each of 90,000 buildings every five years, twice as often as the standard; the cost of repainting is $8 every three instead of five years—the items of $900,000 and $108,000 total $1,008,000.

The cost of repapering 40,000 houses at $30 three times as often as in other cities is $400,000 a year; $150,000 is taken as the cost of cleaning the wallpaper. In like fashion curtain-cleaning and renewing expense is estimated at $360,000, while $84,000 excess lighting bills are computed for an allowance of one-fourth of the average bill of $24 for each of 14,000 homes.

Average Annual Loss

Blank forms were filled out by 115 business concerns indicating an average loss per year of $330. Using as typical 5000 of the 8717 mercantile establishments, the annual loss of $1,650,000 is indicated. An extra precaution expense of $450 for half of the downtown stores totals $450,000, and on the basis of $250 (one-third of the total) excess cleaning expenditure for 3000 stores the amount of $750,000 is obtained. An added lighting cost of $130 for 5000 stores gives that cost as $650,000. The figures for department stores figured separately though on similar bases total $175,000.

One Pittsburgh office building pays $320 more a month than like buildings in New York, Boston or Philadelphia, so $50,000 a year is a conservative loss estimate. To this should be added an excess lighting expenditure of $40,000.

Interviews and returned schedules indicate that in hospitals the cleaning expenses are 50 to 75 per cent greater than if the city were free from smoke. Laundering and lighting are half as much again, and difficulty is experienced in keeping the operating rooms absolutely clean. An average cost of $3,600 brings the excess for the larger hospitals to $55,000.

The methods used in arriving at the total cost, $9,944,740, will be appreciated as possessing unusual thoroughness in connection with an investigation so lacking in precedent. The facts are undoubtedly sufficiently authoritative and convincing to arouse public interest, especially in view of the statement that it has been possible to place no estimate on such conditions as depreciation in property values, compulsory absence of certain industries, impaired mental efficiency and injury to health.

New York State Votes Constitutional Amendments

The constitutional amendments covering "excess condemnation," workingmen's compensation and water-supply development, voted on in New York State at the recent election, were all carried. The figures are not yet available, but the indications are that all were carried by substantial majorities, particularly those pertaining to workingmen's compensation and to water-supply development.

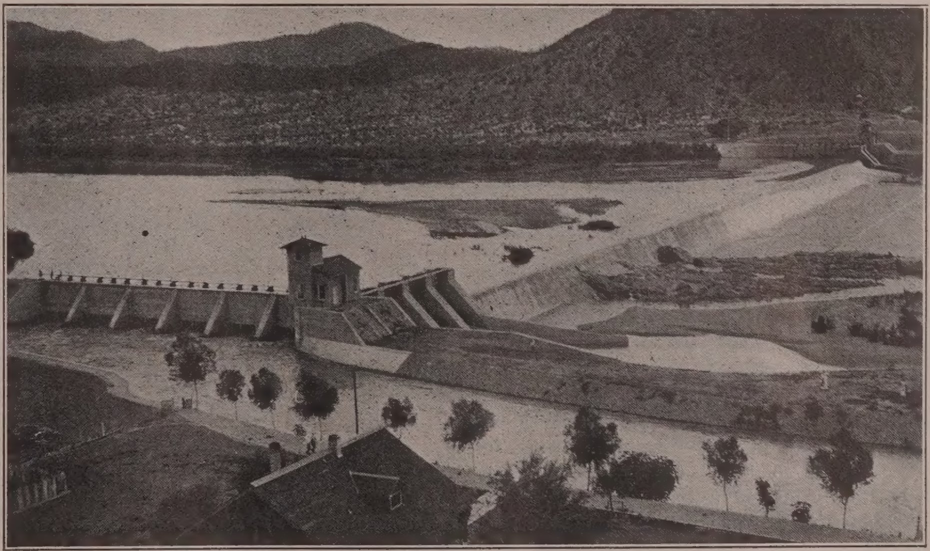
Overflow Dam in Service Five Years

Resistance of Gravity-Section Concrete Dam against Erosive Force of Stream Heavily Laden with Sand and Silt

By A. L. Harris, Consulting Engineer, Phoenix, Arizona

The story of service of an engineering work is not often written, but accounts of construction are very common. This is not especially surprising, for the newly completed structure is turned over to hands other than those that built it, and its new custodians are usually operators who are not called upon to watch results from the designer's standpoint. By the nature of the engineer's profession he is called away to other fields of work where he cannot be a close observer of the service conditions of his past work.

A concrete overflow dam of the gravity type is located on Salt River, about 23 miles east of Phoenix, Ariz. It was built in 1908 by the U. S. Reclamation Service, with which the writer was then connected, and serves to raise the level and divert irrigation water from the river to canals on each side of the stream. Its spillway length is 1000 ft. clear and the water is raised 20 ft. above the former low-water level of the river. In design the principal features were:



Salt River Dam, Showing Intake and Gates for Flushing Sand Catchers

A flood-discharge capacity of about 165,000 sec.-ft. over the crest; provision for preventing the entrance of sand and gravel through the intake gates; founding a part of the weir on a deep bed of gravel and boulders, the remainder being on a rock foundation; and making secure against undercutting at the toe by a specially constructed apron.

Wear of Crest

The large amount of sand, gravel, and other drift moved along the bottom of the river during the characteristic sudden rushes of storm water in this region has completely filled the basin above the dam to the crest. This effect was foreseen and provision was made for mud pressure. It was also predicted that after the deposit of this drifting material had progressed until the river had established a permanent new bed extending up the stream from the dam, any further material would be carried along in floods as usual and go over the dam. Such conditions were naturally expected to wear the crest and rollway of the weir, and the proposal was made to sheathe the more exposed parts with metal. It was decided, however, to defer such treatment until its necessity was fully demonstrated. The crest was carefully put on with natural gravel concrete mixed 1:2:4, and no further work has been done on it during the period of about five years from its completion to date.

The first rise in the river was moderate and occurred about three weeks after the structure had been closed across the stream. Much silt of the finer sort was deposited in the slack water above the dam, which had the effect of nearly sealing up all avenues for seepage underneath the section resting upon the alluvium. Previous to this time springs of this seepage water could be seen boiling up from the open joints purposely left in the apron, but the distance the water had to travel through the gravel beds, and its upward direction in escaping through the apron, evidently prevented the transportation of underlying fine materials. During the next year or so the various rises in the river completed the deposits up to crest level. Since that time many rises of varying heights and duration of flow have run over the dam.

The largest flood that has yet passed over, which happened about six months after completion, rose to a maximum height of 7.2 ft. over the crest and lasted one or two days. The wearing effect on the concrete is probably greatest when the discharge is largest, as only then will the heavier materials be transported along the bottom. Although water does not run continuously over the dam, it has discharged about 1,200,000 acre-ft. in its first five years, equivalent to about 12,000 sec.-ft. running for seventeen months. It should be understood that for considerable periods all, or nearly all, the water flowing in the river is drawn through the intake gates into the canals, and none escapes over the dam.

Forebay Sand Catchers

For preventing the entrance of sand and gravel into the intake gates placed in the abutment walls at each end of the dam a concrete-lined channel was provided to serve as a forebay. The sills of the intake gates were located 4 ft. above the bottom of these channels, and large gates for flushing out the deposits accumulating in the forebays were built into the line of the dam. These sand-catching forebays are sluiced out once a week and are usually found well filled with sand deposits. After a flood they are found to be filled with sand and gravel.

Seeking out the effects of service on the various parts of the structure, the writer made an inspection of the dam in August, 1913, with the following results: The crest and rollway of the dam show little or no evidence of wear. A hard calciferous film was found deposited on much of the crest, and acts as a protection for the concrete. The deposits are probably made during periods of small flow, when alternate wetting and drying occur. These periods occupy much of the time, and when the infrequently big flood comes, the hard film is the first to be worn off. A very heavy flood, carrying stones and coarse sand along the bottom, may some day be able to produce more impression.

Cracks

In the 1000 ft. of weir about eighteen transverse cracks can be seen on the top. Most of these are at the places where the work was divided into sections for convenience during construction. These sections were each made with a vertical V running through the main section, which impedes seepage and prevents getting out of line in case of settlement. Steel rods are also embedded across the joint. The shrinkage has almost invariably relieved itself at these points. A few cracks appear to be the result of shrinkage due to temperature or contraction in setting up. They all grow smaller toward the base of the dam and only a slight seepage of water comes through some of them, as they have silted practically tight.

A weight of about 72,000 lb., distributed over a bearing area of 31 sq. ft. per linear foot of dam, is supported on a gravel bed for about 375 ft. in midstream, the two ends being founded on granite bed rock. A careful levelling showed no sign of settlement in this section.

The apron, which is 75 ft. wide and 18 in. thick, is cut by open vertical joints to divide it into 10-ft. squares. This is not appreciably worn except a little at the toe. It appears not to have heaved on its bed at all. Some seepage water, which is very clear, still comes up in these joints. This would probably amount to less than ¼ sec.-ft., and is likely to grow less. Altogether the seepage coming up from the joints in the apron and rising in the river bed below may reach a total of 1 or 2 sec.-ft.

In two tunnels which extend underneath the sluice gates for the passage of cables for operating the gates the concrete admits a little seepage. No attempt was made at waterproofing during construction except the use of a sloppy concrete and careful spading. During the 7-ft. flood a few sections of the apron which adjoined a ledge of bed rock were undercut, probably by the wear of the rock, which is a coarse-grained, friable granite. No effect was produced on the main structure and the apron was repaired. No other case of the kind has occurred.

Erosion of Waterway

In the path of discharge of the sand-sluicing gates at the south end a wasteway was blasted through the granite and left so. This rock proves much less resistant to the effect of strong currents of water than concrete. In a year's time deep holes and channels had been worn in it, necessitating repairs with a complete concrete floor. No doubt this wearing action was much promoted by the somewhat irregular surface producing much agitation, and by the accumulation of gravel or boulders, which churned in the hollows, thus grinding out "pot holes." This effect in rock-cut channels has several times been observed in this vicinity and indicates, as the medical books would say, a uniform concrete-lining treatment.

Some transverse or inclined lines show a little seepage through the concrete of the main section of the dam and abutments. These are readily identified as contact lines where the surface of the concrete set before pouring was completed above. Any practical concrete man knows that these effects are hard to avoid in large mass work, especially when the hydrostatic head on the forms is enough to require slow pouring. The defect in this case is unimportant.

In general, the entire works are in good condition. The various gates work well. The protection embankments are secure and the concrete construction in wings and gate structures is in excellent shape. Little more satisfaction could be expected of a like engineering work after its first five years of service than is found at this dam.

To Get Long Life from Untreated Timber in Trestles

While the use of creosote, zinc chloride or other preservatives prolongs the life of timber, the processes are expensive. That much can be done to lengthen the life of untreated timber is emphasized by the committee on preservation of timber of the American Railway Bridge and Building Association. Methods suggested by this committee at the recent convention in Montreal are as follows: (1) The selection of the proper varieties for the different parts of the structure—using woods that are durable in contact with the soil for piles and footings and pines and firs for that part of the structure which requires strength but is not in contact with the soil; (2) the use of concrete or masonry footings, keeping all timber away from the ground; (3) keeping drift and other accumulations away from the timber, this applying to the stringers and caps as well as to the sills and posts; (4) cutting the timber at the right time of the year and taking proper care of it during seasoning, and (5) protecting the structure from the weather.

The table gives average values for the life of timber in contact with soil and in air, as estimated by the committee, the figures being qualified by the statement that they vary widely with climatic conditions and also with the properties of the soil. Long-leaf pine and Douglas fir are recommended as the best varieties for structural work, having a fairly long life when not in contact with the soil. Cedar, cypress and redwood, on the other hand, have a fairly long life in contact with the soil, but are useless for beams, etc., as they are too weak and brittle. The all-round excellence of white oak is recognized, but the supply is not sufficient to permit its use for structural purposes.

Length of Life of Various Timbers

Variety	Length of life in years In contact with soil	In air
Cedar	20	..
Chestnut	12	..
Cypress	20	20
White oak	10 to 15	15
Long leaf pine	10	12
Norway pine	6	10
White pine	7	10
Spruce	7	10
Tamarack	8	10
Douglas fir	8	16

It is important in bridge and trestle work, in the estimation of the committee, that all parts of the structure should have the same life, or that the life of one part should be a multiple of that of another. For example, if the piles in a trestle are good for six years and the deck for eight years, a large percentage of the value of the deck is thrown away, as it is seldom economical to put an old deck back on new piles when driven. Again, if the piles are good for sixteen years and the deck for twelve years, a great deal of new material is put in the deck the last year or two, or the piles are renewed before giving all the service possible. Conditions are frequently found where either the piles or deck may be good for a few years more, but the other part is badly decayed and entire renewal is necessary. In pile trestles it is most important by far that the piles have the longest life, as it is much easier to repair or replace any of the other members of the structure.

Piles decay almost invariably at or near the ground line, and many methods have been adopted to increase their life when they become badly decayed. The methods the committee gives are:

1. Splice individual piles by cutting them off below the ground. This method is good where only one pile in a bent is decayed, but not more than one in a four-pile bent or two in a five-pile bent should be so repaired.
2. Cut off all piles in a bent below the ground and put on a framed bent. This is a good method and is probably the most practical one.
3. Either before or after a pile has become decayed incase it in concrete for about 2 ft. below and above the ground line. If the pile is decayed some vertical reinforcement is necessary, and in any case it is advisable to place some wire netting around the pile. If properly done this method is probably the best and the trestle will not lose any of its stiffness. The cost will average about $5 per pile and it will then be good for several years.

Tall Steel Stack with Spread Base

A steel smokestack, 13 ft. 2½ in. in diameter and 204 ft. 5⅝ in. high, has just been erected at the power plant of the Kentucky Electric Company, at Louisville, Ky. The lower part of the stack is curved outward to form an extended base 20 ft. in diameter, which developed stability considered sufficient for the stack without guys.

All of the plates are of soft steel conforming to the specifications of the Association of American Steel Manufacturers. The large base is made of twenty ⅝-in. bent plates, 24 ft. 4 in. long, with double-riveted vertical seams and inside and outside 8 x 8 x ¾-in. circular base angles. Both horizontal and vertical seams are double-riveted for a height of 114 ft. above the top of the base, the thickness of the plate in the first, second and third zones being ⅝, ½ and ⅜ in. respectively. Above this point there are 5/16-in. and ¼-in. plates, with both horizontal and vertical joints single-riveted. The stack is surmounted by a cast-iron cap and also has an exterior circular Z-bar forming a track for a painter's trolley.

Molded radial firebrick were laid up about ¾ in. clear of the shell to make a complete lining, and were supported on shelf angles spaced about 15 ft. apart. The space between the lining and the shell was completely filled with cement grout. The stack was built by the Kennicott Company, of Chicago.

Report on Highway Reorganization in New York State

A plan for the reorganization of the New York State Highway Department—which controls the expenditure of two $50,000,000 bond issues—and a revision of the present new road program to transfer some of the financial burden from the State to the county and town are features of recommendations offered by a board of consulting engineers consisting of Mr. George C. Diehl, Mr. Harold Parker and Col. W. deH. Washington, appointed to study the condition of the department and suggest modifications in its administration. The report, which was made public recently, is summarized below.

The second $50,000,000 bond issue for New York highways, approved in 1912, apportions $20,000,000 for State highways and $30,000,000 for county highways, and divides these amounts among the counties as follows: One-third in proportion to the area of such counties, one-third in proportion to their population, and the remaining one-third in proportion to the total mileage of highways outside of the cities and incorporated villages.

The State system of highways comprises 3617 miles. There are completed or now under contract 1641 miles. There are yet to be completed 1976 miles. Special laws provide for 153 miles.

The county system comprises 8380 miles. The mileage completed or under contract is 2983, leaving 5397 miles to be hereafter provided for.

Plan of Reorganization

The board recommends the following plan of organization: Instead of dividing the work into departments based on theoretical functions, such as planning, construction and maintenance, as at present, it divides the State geographically and makes each division engineer, through the chief engineer, responsible to the commissioner at once for the planning, construction and maintenance of the roads within the territory assigned him.

The only change in the existing law required to put this plan of organization into effect is in the arrangement of duties of the chief engineer and the two deputies. The present law provides for three deputies, having in charge, respectively, plans and construction, maintenance, and town highways, whereas under the plan suggested each deputy handles all three of these functions. These deputies shall have their headquarters in Albany, and each shall be assigned a resident engineer to take charge of affairs in his absence and in a general way to act as his private and executive secretary and chief clerk. Until the law can be amended three deputies as provided by the present law could be used to put the proposed plan into immediate operation or, preferably, discharge the duties as at present through a temporary modification of the proposed plan.

The State is divided into nine divisions, each in charge of a division engineer. Each division engineer shall have in his office a resident engineer competent to act in his absence and to have special charge of surveys, plans, maps, designs, estimates, payments on contracts, etc. He shall also have a chief clerk to care for correspondence, files, preparation of vouchers, etc.

The field work of each division shall be divided into approximately seven sections with an assistant engineer in charge of each. These section engineers shall report to the division engineers and shall be responsible to them. Attached to each deputy engineer's office shall be survey parties to be assigned to the various divisions.

Under the direction of each division engineer shall be three gangs with motor trucks, each to maintain approximately 150 miles of completed State and county roads. The gangs shall be assigned by the division engineers.

The secretary shall have charge of records, reports and correspondence. The amount of clerical assistance will vary within wide limits, depending largely upon the activity of road work.

The auditor shall have charge of all matters of accounting, disbursements of funds and verifications of vouchers. His work will also vary in volume and he shall be provided with such clerical help as is necessary.

Annual Cost

The estimated annual cost of the organization outlined in the report, including salaries, office rent, office expenses, traveling expenses, team hire, operation of motor trucks and wages of repair gangs is approximately $1,180,000 per year. Included in this amount is $296,000, salaries and expenses of patrolmen and maintenance gangs, deducting which leaves $884,000 as the estimated expense of the administration and supervision of construction, maintenance and town highway work.

This organization and estimate is based upon an annual expenditure of $13,500,000, being an average of 6½ per cent for engineering and supervision, a reasonable amount, and $500,000 less annually than the present expenditure for like purposes.

Should the annual expenditure be in excess of $13,500,000, the organization and expenses must be correspondingly increased, but in much less than the proportionate ratio, as the additions should be in the lower grades at lesser compensation, and there need be no increases in the executive officers in charge of sections or divisions.

Traffic census should be taken annually of each completed State and county highway and of each highway for which plans and specifications are in course of preparation.

State and County Highways

State highways are constructed at the sole cost of the State and are intended to comprise those main arteries of travel which connect the several counties and join the larger centers of population. County highways are constructed at the joint expense of the State and counties, the counties paying from 8 to 35 per cent, based on assessed valuation per mile of highway. These are intended to comprise the main market roads.

There are at present planned about 4000 miles of State highways and 8000 miles of county highways, a total of 12,000 miles. An examination of the road map of the State indicates that many roads are unwisely included in these systems and are not of sufficient public importance to warrant large expenditures of State moneys.

Before proceeding further with such improvements, it is especially urged that a careful and impartial study and report should be made by a board chosen by the State highway commissioner for that purpose, to determine a proper State and county highway system, the approximate cost and a sound financial policy.

Assuming that the mileage remains as at present, viz., 12,000, there will remain about 7000 miles to be constructed from the proceeds of the second $50,000,000 bond issue. The average cost of improvement could not be safely estimated at less than $14,000 per mile. Seven thousand miles at $14,000 per mile aggregates $98,000,000, or say $100,000,000. Under the existing statutes, the counties contribute $14,000,000, which with the State's $50,000,000 amounts to $64,000,000, indicating a shortage of $36,000,000 to complete the system as now determined.

Under the original State aid law enacted in 1898, the counties and towns paid 50 per cent of the total cost of construction. It is probable that a careful report as recommended of State and county systems would suggest a method of reducing the mileage to such an extent that sufficient funds would be available if highways were paid for in the following proportions: County highways, State 50 per cent, county 35 per cent, town 15 per cent; and State highways, State 85 per cent, county 15 per cent, without an additional bond issue by the State.

Under present conditions and existing statutes it is apparent that the second bond issue is insufficient; a revised plan must be at once adopted or the system will be left incomplete and disconnected.

Method of Division

The method of division according to mileage, population and area is unscientific, and can only result in confusion and disconnected roads, or unfinished systems. The counties which have an excess of funds will seek to build unimportant roads and the remaining counties will scramble for money, which the existing law apportions to others. The commission, as suggested, could properly determine what should be complete systems within the present bond limits, but a constitutional amendment would be necessary to make any change effective.

The gang system of maintenance herein recommended will effect a saving over the present methods of $700,000 annually, will prolong the life of the roads and keep them in better and more serviceable condition. Unless the State and county highways heretofore completed are placed in a proper condition, without unnecessary delay, such enormous annual maintenance appropriations will be required as will discredit the entire road movement throughout the State.

The question of ways and means of taking care of maintenance is a somewhat vexed one. The present plan of annual appropriation based upon estimated costs and taken directly from annual revenue seems, at all events for the present, the best.

Inspection and Supervision of Town Highways

Town highways are constructed by the town superintendent of highways at the joint expense of the town and State. The amount of State aid to towns between certain limits varies from fifty cents to one dollar for each dollar which is raised by the town. The work is supervised by the county superintendent of highways and in a general way by the State highway commissioner. Much might be said of the value and importance of county superintendents, but scarcely within the scope and limits of this report.

The State inspection of town highways has been carried on under a deputy with a force entirely separate and distinct from the division engineer. There are ten district supervisors who make inspections and report directly to such deputy.

The supervision of town highways and the inspection of town reports and records can be done more conveniently and satisfactorily by the assistant engineer under the direction and control of the division engineer. The control of the division engineer insures uniform practices and standard methods, co-ordination of town work with the State and county work. Citing a specific illustration: Bridges and culverts on town highways which are later to be improved as State or county highways would under such supervision be properly centered, at correct elevations, of sufficient waterway, adapted to and in harmony with future work and requirements.

The present method of approval of bridge plans by both the State and county highway officials causes delay, is unwieldy and cumbersome without corresponding benefits. It is submitted that the bridge plans should be approved by a county or a State official and not by both; preferably by the county, because the county may share in the expense and such a course would prevent delays and permit town officials to consult with the county authorities.

In cases where the county superintendent might not be able to pass upon a complicated bridge structure without outside help, he should have the privilege and opportunity to be advised by the division engineer in charge of the locality wherein the bridge is to be built, and if the bridge is on a proposed or completed State or county highway, the county superintendent should be compelled immediately upon the receipt of bridge plans to report to the division engineer the general features of the plans so that ample opportunity, if desired, might be given the State highway commissioner to issue special instructions to the county superintendent.

The ever increasing use of public highways, especially by motor vehicles traversing considerable distances, makes necessary the installation of direction and distance sign posts. It is believed that such installation should be included in all contracts for new construction and in maintenance contracts, when not provided in the original contracts. All State roads should have well designed concrete or stone mile posts of uniform size and form.

The inscription on the side of the stone toward the approaching traveler should state the name of and the distance to the terminal of the State road toward which the traveler is going. There should also be small concrete stones to mark each tenth of a mile for the use and convenience of engineer and inspector who may thus more readily locate and direct repairs.

Movable Steel Tower Concrete Plant

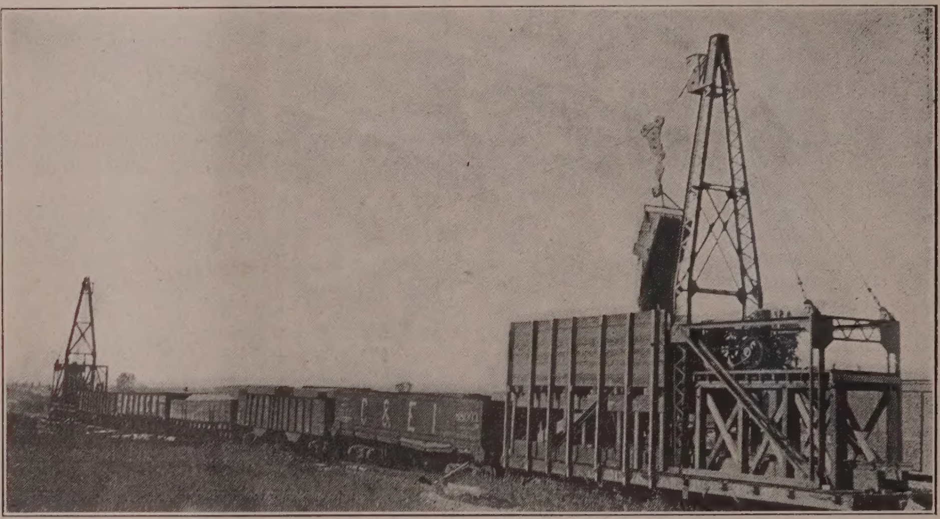
The concrete mixing plant installed in the large yards of the Babcock & Wilcox Boiler Company, at Bayonne, N. J., has a hopper-bottom cylindrical steel storage bin 10 ft. high over all and 16 ft. in diameter, divided by three radial partitions into equal spaces, two of which are used for the storage of broken stone or gravel and the other for sand. The bin has a capacity of 55 cu. yd. and is mounted on braced steel columns supporting the platform for a Smith concrete mixing machine and its operating motor. Cement bags are stored on the charging platform and the mixer delivers to a 2-yd. bucket, which is handled either by locomotive cranes or by a yard gantry traveler by which the storage bin is filled from an electrically closed clamshell bucket. In building a heavy wall to inclose the yard the cost has been $3.25 per cubic yard of concrete placed. The tower and mixer weigh 25,000 lb. and are moved as required.

The Defeat of a Constitutional Amendment authorizing a $50,000,000 bond issue to be devoted to highway improvement in Pennsylvania occurred at the Nov. 4 elections.

Portable Dragline Cableway Excavator for Concrete Aggregates

At concrete plants for track-elevation work runways are generally placed on top of the stone and sand cars and the material is shoveled into wheelbarrows and then wheeled directly from the cars into the charging hopper of the concrete mixer. Such a procedure necessitates the handling of a large number of runway boards and about twenty-five wheelers are required for 150 cu. yd. of concrete material per ten-hour day.

Early in the year 1910 Mr. W. B. Louer, of Chicago, conceived the idea of unloading and conveying concrete material directly from the cars to the concrete mixer by means of a dragline bucket operating on a slack line directly over the material cars and supported at either end of the train by steel towers mounted on flat cars. The details of the equipment were not completed until early in 1913, when the first plant was sold to the Chicago, Milwaukee & St. Paul Railway for use in connection with the Bloomingdale Road track elevation, which is being carried out under the direction of Mr. C. F. Loweth, chief engineer, and Mr. R. J. Middleton, engineer of track elevation. This work was described on page 701 of the Engineering Record for June 21, 1913.



Portable Cableway Excavator Unloading Train of Five Gondolas

Arrangements were made with the Page Engineering Company to prepare a detailed drawing for the steel towers and to use its dragline buckets.

This equipment, as described by Mr. Louer, consists of two 45-ft. folding steel towers mounted on flat cars located at opposite ends of the concrete train. One of these cars is placed immediately behind the concrete mixer and has storage bins so built that the 45-ft. tower may be readily folded over these hoppers. A belt conveyor or charging dump car can be run on a track in the center of the car and underneath the auxiliary hoppers to bring the aggregates to the mixer. The power car, situated at the rear end of the train, also has a 45-ft. folding tower and a special triple-drum 30-hp Lambert hoisting engine, with boiler mounted on it.

General Operation

This plant was designed so that five cars of material could be switched in and the contents unloaded in the auxiliary hoppers of the storage-bin car before it was necessary to make a switch of empties. There is a storage capacity in this auxiliary hopper of 30 cu. yd., which will provide sufficient material for a ½-yd. mixer to work one hour. It has been demonstrated that the supporting cableway can be taken down, the empties switched out and another train of concrete material switched in in forty-five minutes. The concrete mixer, therefore, can work continuously.

On the storage-bin car in the illustration will be noted a platform about 7 ft. high, on which is mounted a small gasoline hoist. Assuming that five cars of material have been emptied and it is desired to switch out the empties and put in loads, the procedure is about as follows: The drag bucket and carrier are hauled in and landed on a platform on the front end of the power car. A ½-in. steel cable runs from the gasoline hoist over the sheave in the top of the steel tower and is attached to a large hook block on the supporting cable, after this block has been unhooked from the tower. The engineer on the power car winds up the three cables on the engine drums. By means of a hand brake on the gasoline hoist at the opposite end of the train just enough tension is kept on the ½-in. dragline to prevent the blocks dragging on the tops of the gondolas. After the supporting and operating cables of the dragline have been wound upon the drums the ½-in. line is unhooked from the cable blocks and laid on the ground alongside the empty cars. If there are trolley wires, telephone wires, or other overhead obstructions which make it necessary, the steel tower on the power car is lowered by unfastening the 1½-in. steel guy cables and then lowering with a hand winch.

Everything is now ready for switching out the empties and setting in the five loads. The operators raise the tower on the power car, attach the ½-in. pay line to the dragline cable blocks and the gasoline hoist on the storage car pulls up the block which holds the main supporting cable. This cable is fastened to the top of the storage-car tower by means of a hook, and everything is in readiness to begin unloading stone and sand from the cars to the auxiliary storage bin. During this time the concrete mixer has not been interrupted, because there was sufficient material in the storage bin to run the mixer for a period of one hour.

Capacity of Dragline

The dragline itself, with a 1-yd. bucket, is said to be able easily to handle 60 cu. yd. of loose material per hour.

It was first thought that the dragline bucket would probably tear out the bottoms of the cars, but experience has proved that this supposition was entirely erroneous. It is necessary, however, to take the wheel off the brake staff in order to make sure that the bucket does not injure the brakes and make them inoperative. The width of the drag bucket is about 4 ft., and it is possible to unload about 75 per cent of the material without the use of any laborers whatsoever in the car, after which it is necessary for two men to get into the car and shovel the remaining material from the sides of the car toward the center. The bucket will then take out all the remaining material in an ordinary gondola car except 3 cu. yd. The bucket is then spotted in the car and two men shovel the remaining material into it.

Crew

Seven men are needed to operate this plant—an engineer and fireman on the power car, two laborers to clean up the five material cars, a signal man to warn the engineer to dump the bucket when he has it over the sand and stone hoppers (this man also attending to the gasoline hoist when a switch of cars is being made) and two men under the hoppers on the hopper car to attend to feeding the sand and stone to the mixer.

This equipment is applicable for use with any style or make of concrete mixer. It is strictly a portable plant and can be prepared for movement from one place to another in not more than thirty minutes.

Mr. Louer, who has furnished the information upon which this article is based, is indebted to Mr. R. J. Middleton, engineer of track elevation of the Chicago, Milwaukee & St. Paul Railway, and to Mr. John W. Page, of the Page Engineering Company, for their help in perfecting the plant. The entire outfit was furnished by the W. B. Louer Company, not Inc., of Chicago.

Appointment of Consulting Engineers on Public-Service Commissions

Remarks Addressed to Governor Glynn of New York by a Committee of the American Institute of Consulting Engineers

The American Institute of Consulting Engineers of New York has written to Governor Glynn urging the necessity of appointing capable engineers to the two public-service commissions of the State. Appointments should be made, it is suggested, from a list of engineers recommended by the institute. The letter, in full, is as follows:

Your Excellency will no doubt be surprised when you hear that we are before you as altruists, with no "axes to grind," and animated by what we believe to be a sincere desire to perform a public duty. We appear as a committee of the American Institute of Consulting Engineers, a national body of engineers engaged in independent consulting practice, to explain to you why we consider that the public interest will be well served by the appointment by you of engineers of broad training to the public-service commissions of this State.

Both of these commissions have duties to perform that are of a highly technical character, calling for a combination of administrative skill and engineering knowledge that can only come through years of experience with the very problems that arise daily in the supervision and initiation of great public utilities.

The commission of the Second District has, first, to do with the safety of travel on the complex systems of railroads that ramify the State. The strength of bridges, the quality of rail, the use of up-to-date signals and the general condition of tracks and roadbed for meeting the exacting needs of fast, heavy trains are matters that call for technical foresight and experience.

The consideration of plans for the costly enlargement of terminals and for the elimination of grade crossings is the next duty of the commission that requires technical skill of a high order to see that corporate and public interests are alike well served.

Then the passing of judgment by the commission on applications for authority to create rival lines and other utilities certainly demands an intimate knowledge of the engineering matters at issue, coupled with administrative and judicial qualifications.

Finally, the investigation of the cost of service in the regulation of rates can only be intelligently done when illuminated by the mind of the experienced engineer.

All of these features are embraced in the daily duties of the up-State commission, and also of the commission for the First District, which latter, in addition, has an added duty in the initiation and construction of a work that rivals in importance the Panama Canal.

New York Subways

The building of new subways in New York City primarily calls for the talents and experience of the engineer, the lack of which was strongly shown in the plan of the original triborough system, that was abandoned, to the great saving of the city of New York, after a public mass meeting of engineers had exposed the inherent faults of its general layout and detail design. It is not necessary, however, to point to the past need of engineering experience in the broader aspects of the subway problem. At the present time, after several years of work, we see many miles of new subways approaching completion, while a vital connecting link at Forty-second Street and Lexington Avenue—in many respects the most difficult of all—has not yet been even definitely located, let alone placed under active construction. The trained administrative engineer surely would plan the building of this great work so that, in a manner the converse of the famous "one-hoss shay," the construction of the various parts would be commenced at varying intervals so that all would come together at one time ready for effective operation. The failure to do this in New York will result later in cries of scandal over a delay of years in opening the new system and the loss to the taxpayers of millions of dollars in wasted interest charges on idle capital—a loss just as real as if the money were burned in the public place.

Engineer as Subordinate

In reply to the argument that the engineer should be represented on these technical commissions the answer often has been made that he can be hired as a subordinate. The highest type of engineer cannot always be secured in this way, any more than would be the case with other professions. The honor of serving as a commissioner would prove attractive to the engineer of standing when the question of remuneration would offer no appeal to him whatever. Then, too, the engineer of broad training on the commission would command the respectful attention of his colleagues, an attention that too often is lacking when equally sound advice may be given by a subordinate official.

Certainly the leading private corporations of the country show their realization of the wisdom of having engineers in their councils, as instanced in enterprises like the change of motive power on the New York Central and the new tunnels and station of the Pennsylvania Railroad at New York, and other great works throughout the country, as well as in the general management of public utilities, as on the Pennsylvania Railroad, Southern Pacific, and more recently on the New York, New Haven & Hartford. In our National Government we have the creation of the Panama Canal under Colonel Goethals as a shining example of the administrative work of the engineer; and in civic affairs, the creditable building of the great aqueduct at Los Angeles.

Abroad we may take inspiration from the example of the cities of Germany, which owe their marked industrial, social and æsthetic advance to the engineering talent to which they have intrusted the direction of their affairs.

List of Engineers

If further illustration is necessary, attention may be directed to the many legal, medical and theological commissions from which the omission of representatives of their respective professions would not be considered, let alone permitted.

In thus urging the appointment of engineers on the public-service commissions we recognize that their selection should not be based on their technical attainments alone, but also on the same degree of business and administrative acumen that should be possessed by appointees from other walks of life.

Should you conclude to act on our suggestions, we believe that a list of suitable names would be presented for your consideration through a request on the presidents of the five national engineering societies of the country, acting possibly in conjunction with the president of a leading commercial body like the Chamber of Commerce of the State of New York.

Military Pontoon Bridges in Swift Water

Pontoon-bridge building on the Missouri River formed part of the field inspection for the Corps of Engineers, U. S. A., in 1912. The work included the selection, loading and transportation of materials, assembling and dismantling of canvas boats, calking of wooden boats, placing anchors, and constructing, maintaining and removing a bridge.

The bridge was built at a site where the water was from 6 to 24 ft. deep and the bottom consisted of hard sand in the channel and soft mud in the eddies. The bottom was so unstable that the main channel shifted 600 ft. in three days and 18 ft. of water shoaled to 6 ft. The maximum current of 7 miles per hour made the work difficult and dangerous and required two anchors upstream for every boat and one downstream for every six boats.

The opinion that anchors travel downstream with the current was disproved by the fact that there was no appreciable movement of anchors cast where the water deepened 12 ft. after they were placed. The operation of the anchors indicated that the effect of a 4-mile current and of a 20-mile wind was about the same in displacing boats. The protection of the bridge from drift was very important and involved difficult night work, including the removal of a tree 3 ft. in diameter that covered five boats in the main channel. It was lifted partly out of the water with chains and levers, cut up and then passed through the bridge. Some of the anchors cast in 18 ft. of water were found to be buried 12 ft. deep in hard sand and after many attempts to dislodge them they were abandoned in the bed of the stream.

Construction of Boats

The sides and bottoms of the wooden boats were made with two thicknesses of ½-in. boards, with heavy canvas between them, and did not need calking. Their buoyancy was considered an important advantage over iron boats, which would sink if swamped. The first bridge, 934 ft. long, which was built with fifteen canvas boats and thirty-two wooden boats, was constructed by eighty-four men in eight and one-half hours.

The second bridge, 1410 ft. long, including a pile approach 128 ft. long, which required twenty-four canvas boats, one steel section boat, five trestles and thirty-six wooden boats, was constructed in fourteen hours by eighty men with the assistance of details for about two hours. The work was described by Captain C. H. Dillon in a recent issue of the "Professional Memoirs" of the Corps of Engineers, U. S. A.

Breaking Up Concrete Walls

In removing concrete foundations from the civic-center site in San Francisco the walls were dynamited and the broken fragments loaded onto dump wagons by steam shovel. The accompanying photograph is of 2-ft. walls, 12 ft. high, formerly supporting Carpenters Hall, located so close to a brick building across the street that small charges of explosives had to be employed.

Holes 1⅝ in. in diameter and 12 to 18 in. deep were driven with Little Giant air drills. Those in the bottom were loaded with one stick of dynamite, while half sticks only could be used in the remainder. These small charges were not nearly so effective as the contractor, the Contra Costa Construction Company, would have liked and had used on walls farther removed from other buildings. Final demolition of the wall into pieces small enough to be handled by a Thew steam shovel had to be accomplished by sledges.

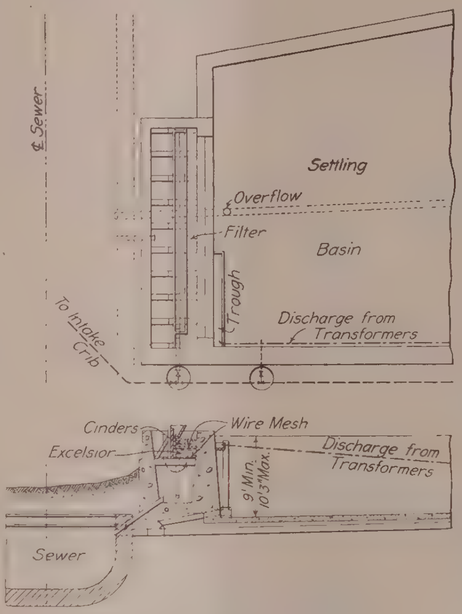
Holes were drilled irregularly, but in a typical section the holes in the two rows at the bottom were 2 ft. apart both ways. In the third row they were 4 ft. apart longitudinally and 2 ft. above and below adjacent rows. In the two rows at the top they were spaced 3 ft. apart both ways.

Wall Shot with Light Charges of Dynamite

Steam Shovel Excavating Concrete Wall Débris

Filter for Boiler Feed and Cooling Water at Omaha

Due to the excessive sediment in the Missouri River water the Omaha Electric Light & Power Company, Omaha, Neb., has had much trouble in the past with the water for cooling the transformers and the boiler-feed supply. The station is located at Jones and Leavenworth Streets, where 15,000 kw are developed by steam-turbine generator sets of the General Electric-Curtis type, as noted in Engineering Record of June 15, 1912. Many things were tried to eliminate the mud, and in 1905 two trapezoidal-shaped settling basins of 165,000 and 240,000-gal. capacity were put into service. As no filters were installed at that time it was found necessary to clean the basins twice a month. At each cleaning 2 ft. of mud covered the basins and during periods of high water much greater depths were deposited.



Boiler Feed Filter at Omaha

Depth of Basins

The depth of the basins varies from 7 ft. 10 in. to 10 ft. 8 in. on account of the sloping 6-in. floor which was reinforced with expanded metal. Overflows are provided which limit the high-water level to 6 in. below the tops of the reinforced-concrete slabs. The return discharge from the transformers is through a wooden trough at the inlet end of each basin, while the suction pipes of the boiler feed pump, transformer cooling-water pump and fire engine pump are at the outlet end along the wall nearest the station,

Treating the Water

To overcome some of the difficulties in cleaning the basins there was devised a system of treating the water with aluminum sulphate and roughly filtering it through a thin bed of excelsior and cinders.

A 7½-hp motor-driven centrifugal pump, running at the rate of 1200 r.p.m., delivering 2500 gal. per minute against an ordinary head of 10 ft., has its suction in the condenser water intake built close to the shore on the harbor line. To prevent the entrance of débris there are two sets of screens with 4-in. openings, cleaned every day.

Water enters one end of the wooden alum trough placed over a long narrow chamber, 9 ft. deep, built outside of the inlet end of one of the basins. The quantity of coagulant varies from 3 to 9 lb., but averages 5 lb. per day, equivalent to 1.17 grains per gallon of water used. On the low side of the trough is a notched weir, which insures an even distribution of the water taken away from the alum trough.

As noted in the drawing showing the cross-section, the coagulated water must pass upward through 2 ft. of excelsior and 2 ft. of cinders before being discharged over the T-rail weir into basin 1. The area of the filter provides an equivalent rate of filtration of 24 gal. per square foot per minute. The chamber under the filters holds approximately 8600 gal., so that there is a settling period of about 35 minutes.

The arrangement has given a satisfactory water for the purposes required and the labor of cleaning has been greatly decreased. It is only necessary to open the drain valve in the chamber under the filters twice a day at times of the worst turbidity. A hose is turned into the chamber to clean the sludge from the end, and occasionally it is turned on top of the filter, which is composed of sufficiently large grains to be easily washed in this manner.

While no accurate tests have been made, Mr. C. D. Duval, to whom the Engineering Record is indebted for the information contained in this article, states that the mud in the settling basins is not over 6 or 7 in. deep, although the basins have not been cleaned since the filter was put into operation in 1910. The filter was devised by Mr. A. C. Anderson, superintendent of power of the Omaha Electric Light & Power Company, of which Mr. H. A. Holdredge is general manager.

Locomotive Crane Removing Form Panels from Retaining Wall

Track Elevation at Piqua, Ohio

Traveling Mixer Tower and Locomotive Derricks Were Used in Casting Concrete Piers and Walls for 2500 Linear Feet of Single-Track Rectification

Recent improvements of the Pittsburgh, Cincinnati, Chicago & St. Louis Railway at Piqua, Ohio, include the rectification of about 2500 lin. ft. of single track of the main line by the construction of a new alignment, about 32 ft. on centers from the old alignment, and 18 ft. above it, with a provision for second tracking. This section of the road lies along the bank of the Great Miami River, across the stream and through the town of Piqua, where it crosses several streets with overhead plate-girder bridges.

General Construction Features

The river crossing is made with five skew spans having concrete abutments and piers on pile foundations, which constitute a heavy substructure. The east abutment, about 53 ft. high over all and 22½ ft. wide at the base, has a 78 x 28-ft. footing and makes an angle of about 120 deg. with a wing wall 300 ft. long, which follows the river shore close to the water line and serves to retain the heavy fill of the embankment approach to the bridge. The river piers, about 40 ft. high and 50 ft. long, are 8 ft. thick under the coping, and the wing wall has a maximum thickness of 22½ ft. above the footing, thus concentrating a considerable mass of concrete at this point.

On the west side of the bridge the tracks are carried through the town on an embankment, retained by concrete side walls about 25 ft. high and 13½ ft. wide at the base, with their ends connected at each street crossing by transverse walls forming abutments for the bridge spans and also serving to retain the fill. All of the work is thus of a heavy character and involves about 15,000 cu. yd. of earth excavation, 100,000 cu. yd. of embankment fill, 30,000 cu. yd. of concrete, and 13,000 lin. ft. of wooden foundation piles. The method of construction and principal equipment installed for executing the work are here briefly described.

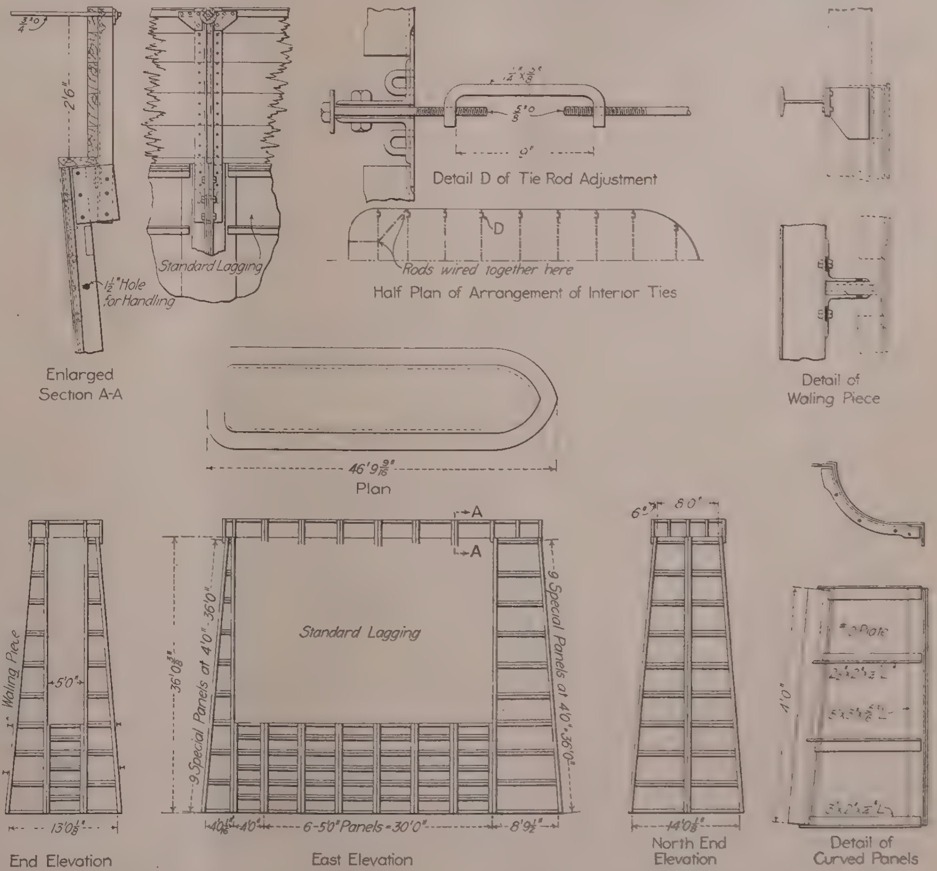
Excavations for the footings were made below water level by two McMyler 20-ton locomotive cranes, operating a 1-yd. orange-peel bucket in the river bottom and a 1-yd. clam-shell bucket on land. One of the cranes was equipped with suspended steel leads, 50 ft. long, in which a No. 2 Vulcan steam hammer was operated to drive the foundation piles to an average penetration of 18 ft. in sand and gravel, about twenty-five piles being usually driven to a refusal of about 1 in. under the last five blows of the hammer in one 10-hour shift by a single machine.

The river piers were constructed in cofferdams 40 ft. wide in the clear, which were built in water about 7 ft. deep with a current of 1 or 2 miles per hour. Serious floods were not experienced at the time this work was executed, and the cofferdams were only built to a height of about 9 ft. above the bottom of the river. Each cofferdam consisted of two rows of 2 x 12-in. vertical sheeting planks spiked to three outside 6 x 6-in. waling pieces. The rows, 6 ft. apart, were connected by ⅝-in. tie rods, 6 ft. apart, through each course of waling pieces, and the space between them was puddled with clay. The bottom of the river inside the cofferdam was dredged to a depth of about 4 ft. and the cofferdam was unwatered by one 8 x 6-in. centrifugal and two Emerson steam pumps.

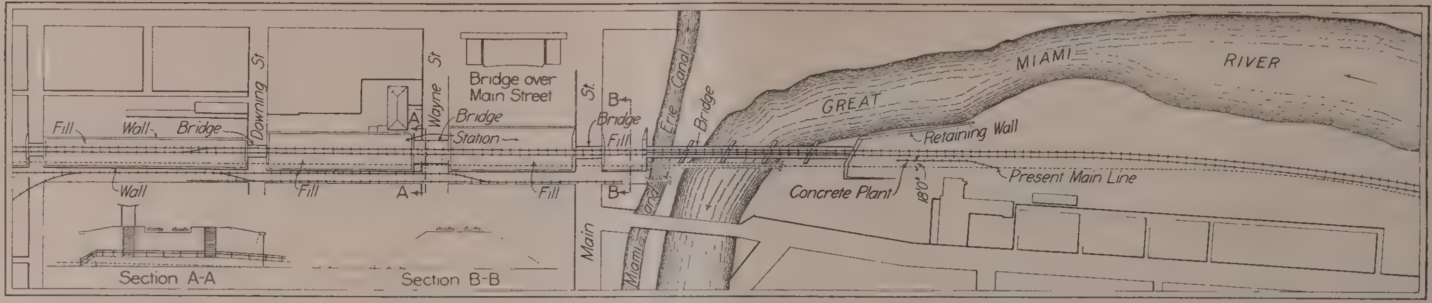
A second cofferdam was constructed inside the first, concentric with it, and had a clear width of 19 ft. It was made of 2 x 12-in. wooden sheet piles, 10 ft. long, braced with horizontal struts, engaging two courses of waling pieces. The earth in this cofferdam was excavated to a depth of 5 ft. below the bottom of the dredged pit, and the concrete footings of the piers were laid on the foundation piles, which were driven about 3 ft. apart on centers, with their tops extending 18 in. into the concrete. The sheeting served as a form for the concrete. Above the footing course the piers were built in special steel forms. The footings of the retaining walls west of the bridge were built in trenches excavated 8 ft. deep by the clam-shell buckets, which generally deposited the sand and gravel excavated from them adjacent to the trench to serve for filling between the walls, thus avoiding hauling the spoil.

Concrete Plant

At the beginning of operations a material track was built to the main line of the railway and was carried along the side hill on a pile trestle 200 ft. long, underneath which storage bins 80 ft. long were established on the slope with a capacity of about 100 yd. of stone and 70 yd. of sand, which were delivered to them from dump cars on the trestle. At the foot of the slope a parallel trench 5 ft. wide and 6 ft. deep was dug and in it there was laid a track for a ½-yd. wooden measuring car, which was filled up to a gage mark with broken stone delivered through a chute from the bin.



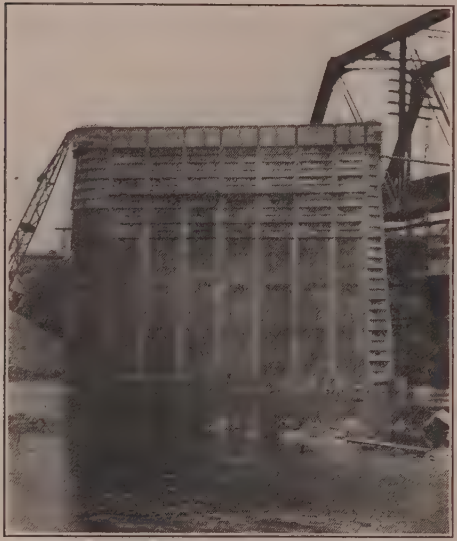
Standard and Special Steel Form Panels for Battered Piers



Map of New Alignment and Location of Bridge Piers, Overhead Crossings and River Walls

The required amount of sand was shoveled into the car by hand and the car was hauled about 150 ft. up an incline by a hoisting engine and automatically dumped into the charging hopper of a ½-yd. Ransome concrete mixer. The mixer was set about 10 ft. above the ground and discharged through a chute into a 1-yd bucket.

For the west abutment and the retaining walls and abutments for street crossings the concrete was mixed in a traveling plant running the full length of this portion of the work, about 1400 ft. Sand and broken stone were delivered at any point along the length of this section on standard-gage gondola cars and were unloaded by a locomotive crane and clam-shell bucket, which delivered to the 16-yd. elevated storage bin in the concrete tower moving on a parallel 16-ft. gage track alongside. This traveler had a ten-wheel wooden platform 40 ft. long, on which was installed a storage bin, about 26 ft. above the track, with a Ransome mixer under it, about 10 ft. clear of the track, high enough to deliver into a ½-yd. wooden bucket, operated in a hoisting tower 40 ft. high on the front of the car. A hoisting engine, steam boiler, and small engine for the concrete mixer were installed on the rear of the car, forming a counterweight giving additional stability for the tower.



Steel Form Panels on Piers

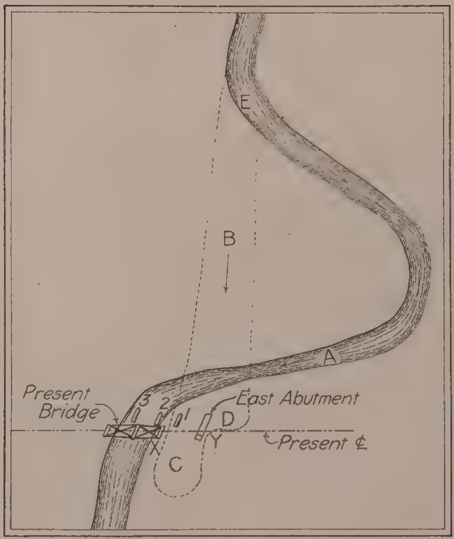


Diagram of Flood Cutoff

The traveler was stationed within a convenient distance of any part of the work and the tower buckets were hoisted to the required height and discharged into a steel chute with U-shape cross-section and a maximum length of 100 ft., that delivered directly to the form and thus eliminated any other transportation or handling of concrete and materials. Cement was delivered by the locomotive crane to the charging platform in the concrete tower. The concrete was mixed 1:3:6 with Speed Portland cement by an average force of eight to ten men. The maximum product of this plant was 150 yd. in 10 hours.

Concrete Forms

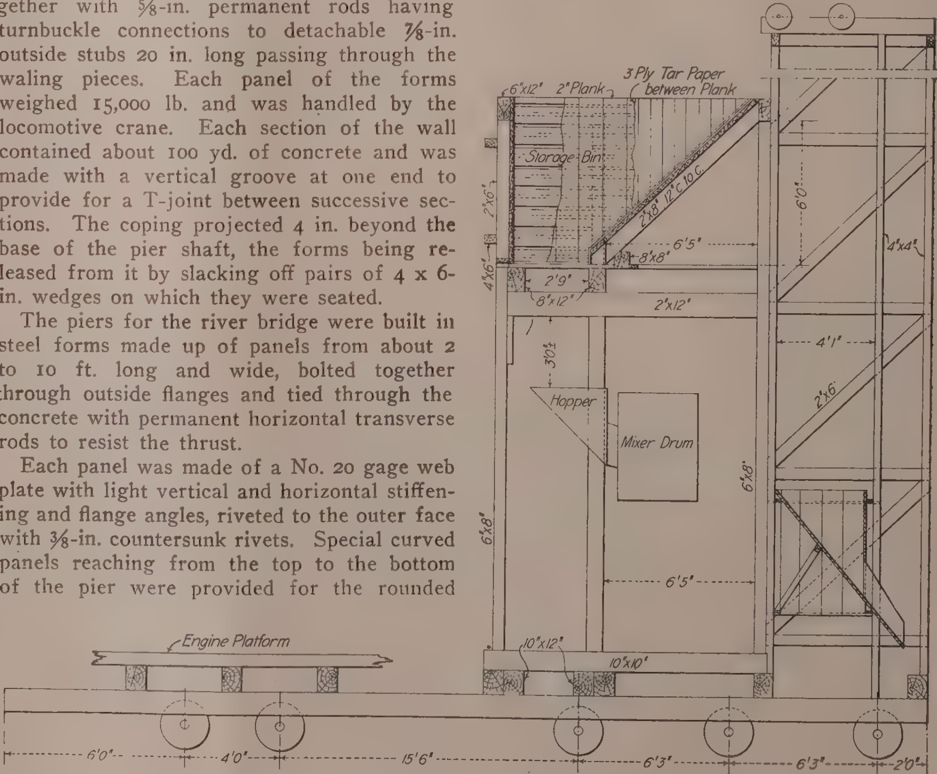
The wall was built in wooden forms with sections 19½ ft. high and 32 ft. long, made of 2-in. square-edge horizontal planks, nailed to 4 x 6-in. verticals 3 ft. apart, with 6 x 6-in. horizontal waling pieces 4 ft. apart, tied together with ⅝-in. permanent rods having turnbuckle connections to detachable ⅞-in. outside stubs 20 in. long passing through the waling pieces. Each panel of the forms weighed 15,000 lb. and was handled by the locomotive crane. Each section of the wall contained about 100 yd. of concrete and was made with a vertical groove at one end to provide for a T-joint between successive sections. The coping projected 4 in. beyond the base of the pier shaft, the forms being released from it by slacking off pairs of 4 x 6-in. wedges on which they were seated.

The piers for the river bridge were built in steel forms made up of panels from about 2 to 10 ft. long and wide, bolted together through outside flanges and tied through the concrete with permanent horizontal transverse rods to resist the thrust.

Each panel was made of a No. 20 gage web plate with light vertical and horizontal stiffening and flange angles, riveted to the outer face with ⅜-in. countersunk rivets. Special curved panels reaching from the top to the bottom of the pier were provided for the rounded upstream end and for the corners of the downstream end, and the spaces between on the long side and on the downstream end of the pier were filled in with 2 x 5-ft. rectangular standard panels, of which enough were provided for two courses 6 ft. high, thus permitting the lower course to be removed and reassembled on the upper course, and so on as the work progressed.

Each course was provided with a horizontal 6-in. I-beam waling, bolted to connection angles riveted to the standard uprights of the panels. The uprights were made of pairs of angles with their outstanding flanges separated about ¾ in. to receive ⅝-in. bolts 10 in. long, with the outside nuts bearing on saddle-plates across the flanges of the uprights. The inside ends of the bolts engaged the ends of flat adjustment bars, which were bent 90 deg. at each end and threaded. The opposite ends of the flat bars engaged the left hand threads of the permanent ⅝-in. tie rods. Holes punched through the flat bars received the points of capstan bars, by which the adjustments were made, pulling the forms up close against the inside braces, which were removed as the concreting progressed.

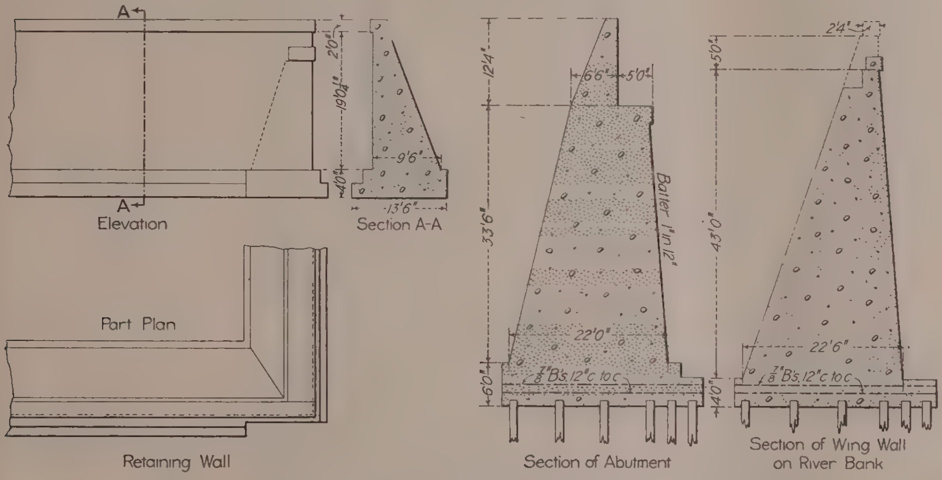
After the concreting was finished the short bolts were unscrewed and withdrawn, leaving the connection pieces and the long bolts permanently embedded in the concrete. At the downstream ends of the piers tie rods parallel to the longitudinal axis were hooked to the



Longitudinal Section of Traveling Concrete Tower for Heavy Work transverse tie rods in the second course from the bottom and had diagonal extensions to the forms to resist the longitudinal thrust without the necessity of carrying the rods through the full length of the pier. The forms for one pier were interchangeable with the other piers and were used four times each for the special end sections and sixteen times each for the standard intermediate sections, thus effecting the entire pier construction with a minimum number of forms, some of which were, after the completion of this job, available for future work.

Connection Angles and Panels

Connection angles were riveted to the upright flanges of the forms at the top of the pier shaft to receive pairs of vertical angles, bolted to them to take the bearing of the horizontal wooden planks making the forms for the copings. The panels of the forms were assembled and taken apart by hand without the use of derricks.



Main Dimensions of New Concrete Masonry on River Bank

The work was designed and executed under the direction of the engineering department of the railway, of which Mr. F. H. Watts is division engineer and Mr. E. H. May engineer in charge. The McKelvy-Hine Company, of Pittsburgh, is the general contractor and the steel forms were furnished by the Blaw Steel Centering Company, of Pittsburgh.

Effects of Recent Flood

The work, although not yet completed, had reached an advanced stage when the recent disastrous floods occurred and occasioned a great deal of damage to it. Mr. A. B. Hine, vice-president of the McKelvy-Hine Company, has supplied the following information regarding the effects of the flood: "The new work stood up well, bore the brunt of the flood and saved the railroad bridge from being washed away. The piers had no bridge or anything to hold them down except the pile foundation and the water was 27 ft. above normal stage. Normally the river makes a bend above the bridge and comes around about parallel with the railroad as at *A* in the sketch on page 548. The railroad company had driven 40-ft. piles from *X* to *Y*, a distance of about 160 ft., to support the track, while pier No. 1 and the east abutment were being constructed; these piles were capped and stringers placed under the ties, but the fill was only partly removed immediately adjacent to pier 1 and the east abutment. This fill and the railroad bridge were covered with loaded cars. The flood broke through the river bank at *E* and the main current came across at *B;* the fill from *X* to *Y* with most of the piling was taken out and the fill at *D,* where the plant was located, was partly washed away.

"The 20-ton locomotive crane, shown at *F*, was carried about 100 ft., upset, and the 50-ft. boom bent back over the cab and twisted out of shape. The remainder of the plant, consisting of a 90-ft. steel concrete tower, concrete mixer, two double-drum hoisting engines, pumps and three boilers, was pretty badly damaged, and one 80-hp boiler has not been located yet. The water on April 15 was still too high to ascertain the amount of damage done. The loaded cars were carried from 100 to 1000 ft. below the bridge. The piles were embedded in the concrete foundation of the east abutment, which was partly completed. The ground in the path of the current *B,* both above and below the bridge, was thickly built up with houses, which were all swept away with the exception of one. That this escaped was a freak of the flood, as it was directly in front of opening. The ground was washed away down to the gravel, and at *C* a deep hole was washed."

Government Favors Arbitrating Colorado Water Rights Dispute

To settle the dispute over water rights between the U. S. Reclamation Service and the State of Colorado, Secretary of the Interior Lane has acquiesced in the proposal of the Colorado State Engineer, Mr. John E. Field, to have the questions arbitrated by a commission of three expert engineers. In his letter to Mr. Field, Secretary Lane, referring to the contention of many, that the diversion of water from the upper reaches of the Rio Grande River would neither seriously affect the flow in the lower part of the river nor the Federal Government's ability to comply with the obligations it has undertaken in the Elephant Butte project, states that he is extremely anxious to discover what this effect is not only as to the Rio Grande but also as to the Colorado. The Secretary has been asked to secure the bringing of a suit to determine the right of Colorado to the exclusive use of her waters. He prefers, however, to have the matter settled amicably. He is therefore prepared to appoint one member of the commission, the State Engineer or the Governor to appoint another, and the two appointees to choose a third. The commission would not be expected to pass upon the numerous applications pending for rights-of-way but to decide whether the State theory or the Federal theory is the correct one as to the effect upon the reclamation projects of the two rivers.

Suggestions for College Course in Logging Engineering

A growing demand for men specially trained to handle the engineering problems met with in the development of the logging industry has been felt for several years in the Pacific Northwest. It has been proposed that courses be instituted in some of the Western universities to give training that would equip students to cope with these special problems, and this year the outlines of such a course were presented by Mr. James O'Hearne in a paper on "How Shall We Teach Logging Engineering?" read before the Logging Congress in Spokane.

Physical traits were touched upon first, as it was pointed out that there were few professions which would call for a greater amount of physical endurance than the logging engineer would need, and the U. S. Civil Service physical examinations were cited as a basis for rating this qualification. For this profession, Mr. O'Hearne said, the student must develop a keen judicial sense and "staying qualities" of a superior order; he must have no trace of the ambition to acquire an education so as not to have to work, for the logging engineer will have to work with his hands and his feet as well as his brains; he must also be "sufficient unto himself," as it were, for he may be required to stay for months at a time in districts remote from civilization, and while there not only do his own work ably but lend cheer and encouragement to others who may be with him.

Subjects for Study

The outlining of a six-year self-supporting course, it was pointed out, was largely the applying of the courses already taught to the special needs of the logger, and combining with this a certain amount of field work. For this the faculty would require one extra man, Mr. O'Hearne thought, who should be a practical logger. The features recommended to be drawn from established courses were as follows: From liberal arts, English composition and one foreign language, preferably Spanish; from mechanical engineering, drafting, machine practice, knowledge of foundry work, and a study of internal combustion engines; from mining engineering, geology, tool sharpening and tempering, and first aid to the injured; from civil engineering, mathematics, surveying, mapping, railroad, location and construction, railroad structures, maintenance, operation and safety appliances; from electrical engineering, general principles of applied electricity.

The need of a text book on logging was emphasized and it was suggested that this might be prepared by a committee of representative loggers appointed from the different districts and working in conjunction with the professors of forestry in Western universities. Help on this work might be expected, Mr. O'Hearne thought, from the Government Forestry Department, which has made extensive studies of logging conditions in the Northwest. Whether embodied in one text book or selected from general sources, the subjects essential to logging engineering and, to a certain extent, peculiar to this course, might be arranged under the following heads:

Forestry.—A study of the different species of trees, their special adaptation to certain regions, rate of growth, mechanical properties, diseases and decay, and their insect enemies. Under this head would also come reforestation, fire protection, fire fighting, attention to fire-killed timber—how soon it must be logged and the rate of depreciation of the different species, the best methods of logging to prevent waste, and a general study of lumber, shingle and pulp mills.

Engineering.—Cruising and making topographical maps; planning different methods for the removal of timber and estimating cost by each method; laying out and building skid roads, railroads and cableways; figuring the most economical motive power for moving logs to their destination, and planning log dumps, booms, flumes and chutes.

Logging.—A study of each operation of the various methods used in removing the standing tree and placing the log on the car or other means of transportation; the kind and size of engines, blocks and lines; the advantages in long or short crews and long or short hauls; the advantages of different fuels; the location and plans for camps; the limiting distance a crew should walk; the maximum length of ride, and the number of men that can well be housed in one camp.

Sanitation.—Under this head comes the location of buildings with reference to one another and to barns, pig pens, etc.; the source of water supply; care of refuse from cook house; disposal of wornout clothing and shoes; and condition of sleeping quarters of men.

Efficiency.—Last but not least care should be taken to impress upon the student the value in dollars and cents of studying means of standardizing processes and eliminating waste; comforts and the inducements to special efforts that may be offered in camp; and what means may be taken to prevent trouble and discontent among the men.

FIELD WORK

Six months of each year could be spent in the woods to good advantage, Mr. O'Hearne thought, the field work being arranged to run from April to September. This would give the student opportunity to get practical experience, which is a very important element in such a course. For the first field season the student could fill only subordinate positions. He would fire donkeys, give signals, cut wood, swamp, and, on occasion, could assist in bucking and second falling, the idea being to change around enough to get the benefit of experience in all minor positions. The preferable location, Mr. O'Hearne said, would be in a large logging camp where several methods could be observed and where a contract could be secured for the actual delivery of logs at so much per 1000 ft., the student to do the work under the leadership of experienced loggers. Profits on such a contract should be divided equally among the students, who would be paid the usual rate for common labor. The student should eat in the regular mess house with the crew, but should have separate sleeping quarters, where facilities for notebook work and study were provided.

VARIETY IN STUDIES

Outside work for the second and third years must be varied, Mr. O'Hearne said, and the student should be sent to different camps so as to see different methods of logging in operation. Camp accounting and cost statements, made up from actual work done, should be taken up in connection with log scaling. It should also be arranged to have the student assist in laying out and building a camp as well as repairing donkey engines, fighting fires and take some part in every phase of camp work not covered in earlier field seasons.

In the fourth year the student should begin to run compass, cruise and run levels. In this work the student will find it harder than before to keep up his earning-power capacity, Mr. O'Hearne stated, but if he had been successful in the preceding three years his reputation should help him to follow the line of work needed at least part of the season.

TAKING A CONTRACT

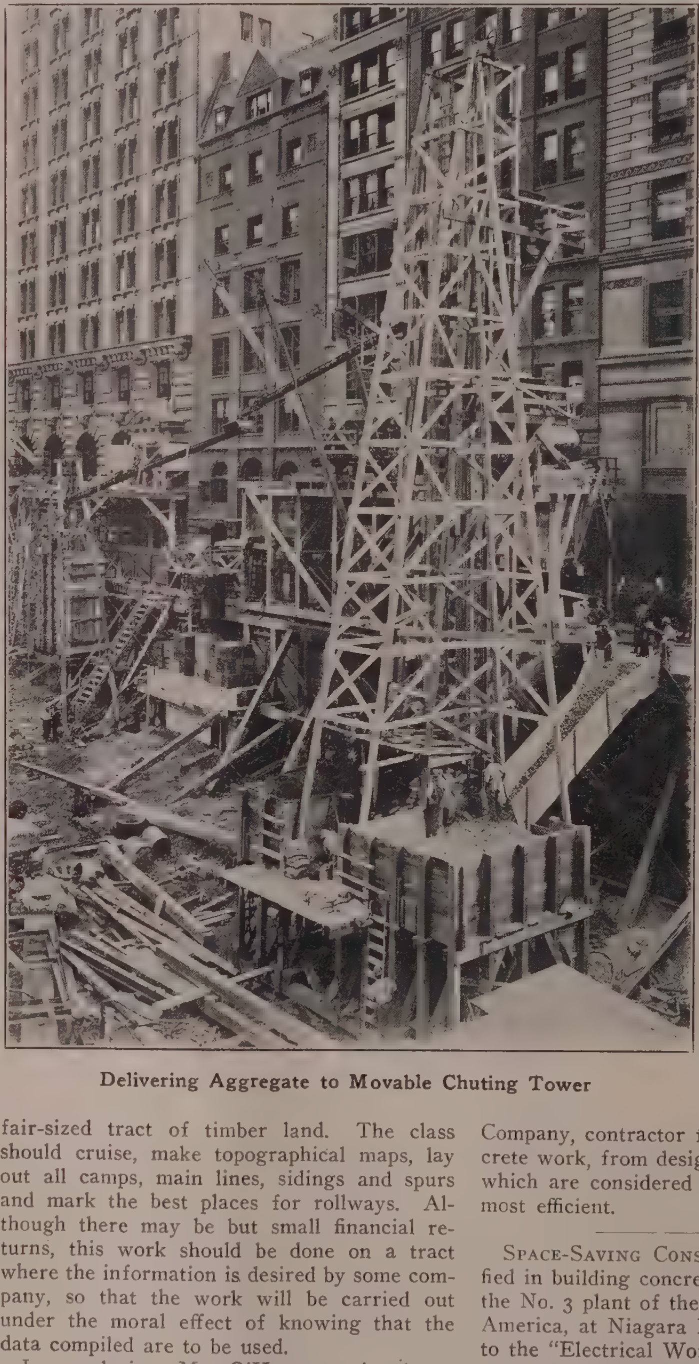
In the fifth year the laying out and grading of logging spurs should be featured. A contract might be taken to lay out and grade a certain stretch of road, or a place on a crew doing this work might be secured for the student. During this year the student should sharpen and temper drills and picks, learn to use powder and help build bridges and trestles. Actual costs of earth, rock and trestle work should be compared in the light of financial or other reasons for selecting them.

The sixth and last field term should include all the work required to open for logging a fair-sized tract of timber land. The class should cruise, make topographical maps, lay out all camps, main lines, sidings and spurs and mark the best places for rollways. Although there may be but small financial returns, this work should be done on a tract where the information is desired by some company, so that the work will be carried out under the moral effect of knowing that the data compiled are to be used.

In conclusion, Mr. O'Hearne pointed out that if the student commences this course at the age of seventeen or eighteen he should graduate at twenty-three or twenty-four, able to start in as a very efficient assistant to the superintendent of a large concern or to handle the engineering problems of a smaller one.

Movable Concrete Chuting Tower

The construction of the pneumatic-caisson foundations for the thirty-eight-story Equitable Building in New York, described in the Engineering Record of Aug. 30, page 247, will require about 12,000 yd. of concrete, besides about 8000 yd. more of concrete in the interior piers. The caissons are built on the bottom of the preliminary excavation, about 25 ft. below the curb, and the concrete for them is mixed in three ½-yd. Ransome machines installed in three movable wooden towers 85 ft. high, that are located near the Pine and Cedar Street lines on opposite sides of the lot and on Nassau Street.



Delivering Aggregate to Movable Chuting Tower

Concrete material delivered daily in wagons is chuted from street level to storage bins of 50 yd. capacity built in connection with the towers. The bins deliver by gravity to the charging hoppers of the mixing machine and the latter deliver to hoists in the towers, from which the concrete is distributed by the regular Lakewood system of suspended chutes to any point in the lot.

As a large portion of the area of the lot is covered by the caissons and piers it is difficult to locate the towers so that they will not interfere with some of the substructure work. They are, therefore, built, together with their storage bins, on horizontal timber sills, like skids, which enable them to be easily moved in any direction in order to clear or reach any given pier and then to be moved back again if necessary to clear or reach other piers.

The three plants have each a capacity of 40 batches of concrete per hour for the machine and for the hoisting apparatus, allowing for all reasonable delay. The apparatus has been installed by the O'Rourke Engineering Construction Company, contractor for the caisson and concrete work, from designs that are original and which are considered by the contractor to be most efficient.

SPACE-SAVING CONSTRUCTION was exemplified in building concrete poles into the side of the No. 3 plant of the Aluminum Company of America, at Niagara Falls, N. Y. According to the "Electrical World," the reinforcing extends up to the side of the building, continuing to a point near the top of the pole, which is 10 ft. above the roof, and is braced to it by reinforced-concrete arms. This construction has permitted placing a spur track so close to the building that unloading and loading cars is greatly facilitated.

Dipper-Dredge Work on Neponset River

Rectifying and Deepening Main Channel of River to Remedy Insanitary Conditions

By Edmund M. Blake, Engineer in Charge, Massachusetts State Board of Health

An outline of the work now being carried on by the Massachusetts State Board of Health in the improvement of the Neponset River was published in the issue of June 1, 1912, of Engineering Record. The legislative act under which this work was finally authorized directed the State Board of Health to expend $150,000 in rectifying and deepening the main channel of the river from a point near the dam at the Mattapan Paper Mills in Hyde Park to a point below Pleasant Street in Norwood, and authority has since been granted for the additional expenditure of $40,000.

It was impossible to take a dredge upon this work by water on account of the four dams which exist between Hyde Park and tidewater. The contractor decided to install first a heavy dipper dredge in the Hyde Park section at a point above the group of pile bridges in the train yard of the New York, New Haven & Hartford Railroad at Readville. These train-yard bridges, set very low, constitute the greatest obstruction to the flow of the river and are impassable for dredges. Their ultimate treatment has not yet been decided upon, but it is likely that radical changes will be made conjointly with the railroad. The dipper dredge was to handle the work from these pile bridges up to a point in the meadows near Dedham Road, at which point the main-line plate-girder bridge of the Providence division of the railroad forms the upper terminal of operation for this dredge, a section about 27,000 ft. in length.

Description of Dredge

This dredge was built by the Fairbanks Steam Shovel Company, of Marion, Ohio, and may be described briefly as follows: The steel hull is 70 ft. long, 18 ft. wide and 6 ft. deep, made up of ten transverse sections each 7 ft. long, bolted together and braced inside with longitudinal and transverse steel plates and beams. The boom, built of heavy oak, is 60 ft. long and turns on a half circle rollway. The dipper arm, 40 ft. long, carries a heavy steel dipper with a full loading capacity of about 1¼ cu. yd. In ordinary digging the dipper is fitted with a hardened-steel jaw. To this are attached three extra-heavy manganese-steel teeth when dredging in cemented gravel or hardpan with boulders. The boiler is of the horizontal marine type, of 50 boiler hp. When operating two eight-hour shifts the coal consumption is approximately 2 tons per twenty-four hours, including banking charge.

The crew required in operating this dredge consists of a dredge runner, a craneman, a fireman for the boiler and a "roustabout." The latter is a helper for odd pieces of work and is not constantly employed. He is generally combined with another "roustabout," and together they load coal into the scow, tow it to the dredge and unload it on the dredge. Later on in the winter the contractor purchased a motorboat for towing the coal scow back and forth and a man was secured to run the motorboat and do other odd jobs.

Typical View of Neponset River before Dredging, Looking Downstream

Operation

The dipper dredge started operating in a section of the river bounded at the upstream end by the historic Pauls Bridge in Milton and at the downstream end by a plate-girder bridge on the Midland division of the railroad. This section was very accurately sounded and full data were obtained in order to determine very closely the records of dredging. The base width of the new channel was 34 ft., with a depth of 6 ft. except at two points where the depth was increased to 7 ft. and the base width decreased to 23 ft. In all cases the side slopes were 2 on 1. The banks on both sides were lined with trees and brush throughout the greater part of this section, most of which were on property of the Metropolitan Park Commission, and it was necessary to preserve as many of them as possible. This greatly increased the difficulty of depositing material on the banks and was the cause of more or less delay. At one point a 10-in. flexible-joint cast-iron water pipe crossed under the river, seven lengths of which were taken out by the use of the dipper and landed on the bank with only two injuries to the pipe—breaks in two of the bells.

Going upstream the right half of the channel was dredged, and the other half was dredged after turning around at Pauls Bridge and proceeding downstream. It was then found that the dredging had not been carried to the required grade in many places, and the dredge was required, therefore, to "clean up" to line and grade on the return to Pauls Bridge.

As plotted from the final soundings, the cross-sections revealed an unusual accuracy in the lines and grades of the dredged channel, which is all the more worthy of comment because in this section there were encountered all classes of material from silt and fine running sand through gravel, blue clay, bouldery gravel and hardpan. Only a very small percentage of river silt was dredged, and at no time could it be said that the spoil banks had any objectionable odor.

The capacity of the dipper dredge when operating in ordinary material is rated at about

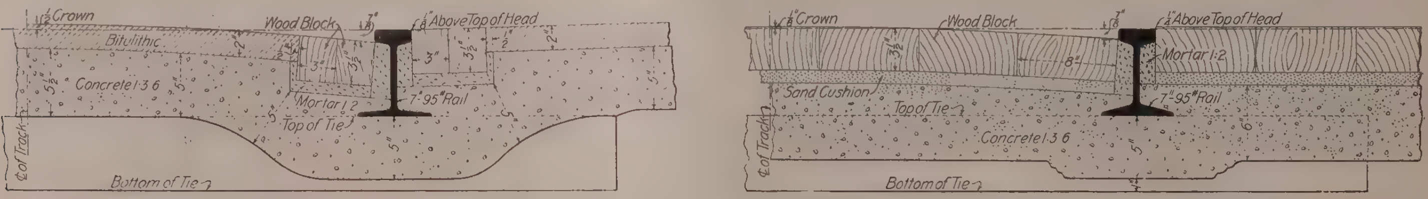
Dipper Dredge Blocked and on Rollers for Transferring across a Street

1000 cu. yd. per twenty-four hours, or about 30,000 cu. yd. per month. Its performance under the above-described conditions, as covered by the following figures, an average of between 9000 and 10,000 cu. yd. per month, is fairly creditable, nevertheless, when taking into consideration the general hardness of the material and the difficulty with trees and brush on the banks. The figures covering the dredging of the new channel in the above-mentioned section are shown in the table.

The figures used for approximate costs of labor and coal are probably in excess of the amounts actually paid by the contractor.

The "overhead charges," interest on plant cost, plant depreciation, etc., figured by the contractor against this completed section of the work are not available.

The dipper dredge was transferred around Pauls Bridge without dismantling, except to remove the boom, dipper, dipper arm and some of the cables, after completing the above-described channel. Its transfer was accomplished by the use of blocking, cables, capstans and horses, much the same as in moving a building. This work was seriously delayed by the presence of very high water in the river, which made the removal of the dredge from the channel to the bank a difficult operation.



Part Cross-Sections of Bitulithic Pavement at Greenwich and Wood-Block Pavement at Norwalk

It was, therefore, not until May 8, 1913, that it was finally relaunched above Pauls Bridge. Dredging was again started on May 12, and at the time of writing this article it had proceeded to a point nearly 1 mile above Pauls Bridge into the meadows. Soft material was encountered about 700 ft. above Pauls Bridge, and the rate of progress since that time has been much faster, and probably will approximate 20,000 cu. yd. per month.

The ranges used in marking line for the dredge consist of an ordinary 1-in. iron pipe, varying from 6 to 10 ft. in length. They are set on cross-section lines swung from the reference base lines at such intervals as may be necessary to define accurately the channel to be dredged. In most cases four ranges are set on each cross-section line, the two middle ones marking the lines of the base of the channel and being flagged with red flannel, with the two outer ones marking the points of intersection of the side slopes and the present bottom of the river. The dredged material is required to be kept 7 ft. back from these outer ranges, which are flagged with white flannel. River gages are kept ahead of the dredge with special heavy marking; they read direct from the base grade.

CHANNEL-DREDGING DATA

Profile length, 34-ft. base	3950.90 ft.
Profile length, 23-ft. base	340.70 ft.
Work began	Jan. 28, 1913
Work ended	March 27, 1913
Number of working days, primary dredging	42
Number of working days, "cleaning up"	9
Total number of working days	51
Equivalent number of working days of single shift of eight hours	103.25
Total number of working hours, including time spent on repairs and other delays	826
Total yardage dredged to lines and grades (T)	13,617.10
Total yardage allowed for 6-in. excess outside of lines and grades (S)	2,308.10
Extra yardage allowed at 10-in. pipe crossing (E)	231.90
Total yardage for which contractor was paid	16,157.10
Gross total yardage dredged by contractor (D)	18,420.80
Percentage of excess of D over T	35.3
Percentage of excess of D over T + S + E	14.0
Percentage which S is of T	16.9
Yardage dredged per lineal foot, D	4.29
Yardage dredged per lineal foot, T + S + E	3.76
Average yardage, D, dredged per day	361.2
Average yardage, D, dredged per hour	22.3
Average yardage excavated per day, paid for	316.8
Average yardage excavated per day, not paid for	44.4
Percentage of average cubic yards, D, excavated per day, not paid for	12.3
Labor charge, including timekeeper	$1,603.35
Tonnage of coal used	107.5
Cost of coal at $4.00 per ton	$430.00
Cost of labor and coal	$2,033.35
Labor charge per day	$31.44
Labor charge per hour	$1.[illegible]
Cost of coal per day	$8.43
Cost of coal per hour	$0.52
Average cost of labor and coal per cu. yd. of gross excavation	$0.11
Average cost of labor and coal per cu. yd. of excavation, paid for	$0.126
Price paid contractor, as per agreement, per cu. yd.	$0.42
Cost of labor per cu. yd. of gross excavation, D.	$0.087
Cost of labor per cu. yd. paid excavation	$0.099

The contract for relaying the 10-in. flexible-joint cast-iron water pipe referred to has been let to the Crandall Engineering Company, of East Boston, for the sum of $790, the board to furnish special castings, gate valves and boxes. This work is now under way and the contractor has erected a scaffold across the river from which the pipe will be suspended and the joints leaded and calked before lowering to the bottom of the river. The dredging is being done by the Barge Canal Construction Company, of New York, which is composed of Messrs. Charles Longenecker, George W. Beeman and Louis B. Harrison. All of this work is under the direction of Mr. X. H. Goodnough, chief engineer of the State Board of Health, with the writer as engineer in charge. The engineering assistants at present employed upon the work are Messrs. N. L. Hammond, H. S. Wright, C. F. Joy, W. G. Norteman and C. C. Topham.

Supporting Tracks under Traffic during Construction

The design and construction of the temporary structures supporting tracks under traffic during the prosecution of work underneath, such as the building of highway or street undercrossings, have a large bearing on the total cost of the work. This is especially true where the traffic is heavy and high speed is to be maintained. At the recent convention of the American Railway Bridge and Building Association Mr. R. H. Reid, supervisor of bridges of the Lake Shore & Michigan Southern Railway, described work at various points where three systems of support were successively required as the work proceeded.

At Sandusky, Ohio, a street crossing seven tracks at grade was to be carried under without altering the track profile. The solid-rock surface was about half way down, and above this were boulders and hardpan. Pile bents were built, the piles being driven to refusal. In the floor system supporting the tracks there were incorporated two sets of stringers, one spanning from bent to bent and the other balanced on the bents.

As the excavation proceeded ridges were left to protect the piles, the intervening spaces being taken out to solid rock. Some of the piles were found broken, and in such cases short posts on sills were pushed in to replace them. When the rock surface between bents had been reached frame bents were erected in the middle of the spaces, catching the ends of the secondary system of stringers, which, like the primary system, were designed to carry the full load.

The pile bents were then removed—all except the caps, which were left bolted to the stringers; then the remainder of the loose material was cleaned away and trenches were cut to the full depth required for the excavation, the trenches being directly in the line of the original pile bents, and the whole system being so spaced as to avoid the permanent abutments and intermediate piers. New frame bents were then constructed in the trenches and the load transferred to them, after which the bents on the higher level were in turn removed. The excavation is now being completed, and the next shift will be to the permanent bridge. During all of this work there was no call for slow orders.

A somewhat different treatment was required at Cleveland, where a street crossed six tracks at grade on a sharp skew. Here as at Sandusky it was proposed to cut the street under without changing the track profile, but the rock surface was only about 4 ft. below subgrade.

Of the four main tracks the two interior ones were put temporarily out of service and the soil underneath was excavated to rock. Two sets of stringers were used as at Sandusky, the secondary set, however, being placed on top of instead of alongside the primary set. The stringer system thus filled most of the space between subgrade and rock, and the first system of supports consisted simply of sills and blocks, spaced 20 ft. apart. Thence the procedure was similar to that at Sandusky, the second set of bents being carried in trenches about half way down, and the third set resting on the bottom of the finished excavation. On account of the sharp skew of this crossing a moderate slow order was required.

T-Rails in Paved Streets

Whether T-rails for tracks should be allowed in paved streets or whether girder rails should be required, and the best methods of fitting the different types of pavements to the tracks, are still unsettled questions. The Connecticut Company, which is the operating company for the electric lines of the New York, New Haven & Hartford Railroad, is using T-rails extensively with various types of pavement, and cross-sections are shown of two of the designs in use.

In a recent article in the "Electric Railway Journal" Mr. R. C. Cram, formerly assistant engineer of the Connecticut Company, expresses the belief that much of the objection that has been raised to the use of T-rails should have been brought against the type of pavement used in connection therewith. He states that the T-rail construction built in accordance with the company's standard cross-sections has generally given satisfaction. In narrow streets carrying heavy vehicular traffic he thinks girder rails may be preferable, as the rail grooves will take the brunt of the loads that follow the rail, reducing the wear on the pavement.

Tuning Up Filters at Albany, Oregon

Process of Putting a Water-Purification Plant of Rapid Type into Successful Operation and Training the Attendants

When the new 3,000,000-gal. rapid-filter plant at Albany, Ore., the only modern plant of any size on the Pacific Coast, was put into operation in the late summer of 1912 difficulties arose in getting a uniformly clear effluent, for the operators were non-conversant with filtration practice and were required to divide their time between this plant, an adjacent pumping station and a power plant. This contingency led the management to secure more trained assistants in putting the plant, which was described in the Engineering Record of Aug. 17, 1912, page 192, into good working condition and in training the operators. Briefly, this involved the adjustment and regulation of the various gages and registers, the calibration of the filter controllers, chemical-feed orifices and raw-water pumps, the installation of a self-cleaning screen at the intake and a temporary soda-ash equipment, and, finally, training the operators to make the essential chemical and physical tests and keeping a comprehensive report of the operation of the plant.

SELF-CLEANING INTAKE SCREEN

To overcome the very frequent clogging of the screens in the intake-screen well during the fall of the year, when leaves in large quantities are carried by the water, with the attendant air-binding and clogging débris of the 6-in. low-lift Worthington volute pumps, an additional protection was provided by attaching over the 16-in. intake elbow a circular-hood screen of 1-in. mesh, 3 ft. in diameter by 3 ft. long, with a metal bulkhead on its downstream end. The circular screen, which is supported on piles, is connected to the spigot end of the bend by a number of longitudinal ¼-in. rods secured to the bend by a band. A solid casing, which assists in stiffening the screen, is placed around these rods on the taper so that all water passes through the cylindrical screen. The velocity of the canal flow is about 7 ft. per second at this point, and the screen is very effective in keeping itself clean. It is thought that a ½-in. screen would be still more satisfactory, as much débris passes through the 1-in. mesh. Occasionally the screen is cleaned by back-flushing from the basins.

TEMPORARY SODA-ASH EQUIPMENT

Analysis of the water showed that a poor effluent was due in part to insufficient alkalinity to care for the dose of alum required by the turbidity. As is often the case with surface waters, a rise in turbidity was always accompanied by a decrease in alkalinity. A temporary soda-ash feeder was installed comprising two sets of three 45-gal. barrels, each row of barrels being interconnected bottom to bottom and closed from the adjacent barrels by a valve in a 1-in. pipe. Three per cent. solutions were mixed by dumping the weighed dry soda ash in a slow stream into each barrel, which was separately filled with water, the valves between them being closed to prevent any mixing until the solutions had become constant in strength. At first a paddle churn was tried, but was found useless on account of the crystallizing of the soda ash. One of the duplicate alum-feed orifice boxes was used to measure the solution. The point of application was at the entrance to the mixing basins following the alum application. This made it necessary to apply the alum at the pump.

Rather than connect the alum piping to the pump suction, and possibly admit air thereto at times of low head in the canal, the alum was fed into the pump discharge just beyond the pumps through a single perforated pipe tapped into and extended to the farther side of the pipe. Bottle tests were made to determine the correctness of this order of application. As no accurate measures were available, a drop was used as the unit of volume. The same number of drops of soda-ash solution and of alum was added to a measured amount of raw water, about 500 cu. cm, so as to give the probable dose of each chemical required. Each bottle was given identically the same amount of agitation and treatment, save that alum was added first to one and the soda ash first to the other. Repeated tests showed clearly that the best floc was obtained by adding the alum solution first. Apparently a slight mixing after adding the alum was all that was necessary before adding the soda ash.

In actual operation the soda ash was applied to the alum-treated water through a grid placed at the entrance to the conduit which supplies the basins.

MINOR CAUSES OF POOR EFFLUENT

Aside from the fact that additional alkalinity was necessary, a poor floc, or none, was often obtained due to the fact that the accumulation of air and débris in the pumps decreased the normal rate of pumping and, unknown to the attendants, the alum dose would increase, sometimes far beyond that warranted by the alkalinity, natural or applied, and the water would become so acid as to redissolve the floc. When the pumps behaved in this manner it followed that within a few minutes the level of the water on the filters would drop. Occasionally the filters were found completely empty. To indicate this condition an additional contact was arranged on the loss-of-head gage alarm so that when the level dropped about 1 ft. the dial movement due to the drop completed the circuit through an alarm in the power house, indicating a falling off in the rate of pumping.

Still another cause of poor effluents was the fact that the attendants were making no use of the filter controllers. Instead the regulation of rate was accomplished by manually opening or closing the effluent valves. At times the rate must have been very excessive.

CALIBRATION OF RAW-WATER PUMPS

Although theoretically the raw-water rate of pumping should be constant, under the conditions obtained at Albany this was not the case, as noted previously. The air became entrained in the water, very largely due to the overfall of water through the clogged screens; but even with clean screens it appeared that under the 6-ft. suction lift air was liberated from the water. Hence it became necessary to measure the raw-water flow. Instantaneous information on this point could not be obtained, but a fairly good measure could be made easily, and as often as the attendants were inclined, by closing the outlet of the coagulating basin and timing the rise of water level in them on one of the basin gages in the operating room. These gages were accurate to about 0.002 ft. A diagram was constructed to give the rate of pumpage knowing the time observed to rise 0.01 ft. in the basins.

Several diameters at different depths in the circular alum-solution tanks were measured to check the capacities. The soda-ash storage barrels were calibrated by measuring their contents at different depths with a 5-gal. can. The recording-depth gage on the alum solution tank was adjusted by turning its dial until the indicator depth agreed with the measured depth in the tank.

The orifices were accompanied by a discharge chart based on a 6-in. head over the orifice. As this head was so close to the top of the box that often the float valves would not close before the box overflowed, the head was reduced to 5¼ in. and the adjustable rectangular orifices recalibrated by timing and weighing their discharge for various indicated openings.

An especially constructed alarm was installed on the orifice boxes to call attention to any variation in this height. A gutta-percha rod pivoted to the float stem was arranged to make electric contact in a saddle set on the float valve and insulated from it, and when the water level varied about ¼ in. up or down causing the alarm to ring. This alarm also indicated the emptying of the solution tank.

To provide for easy and frequent cleaning of the solution-pipe lines which become clogged up after about three months' use bends were replaced by plugged tees or crosses so that wires could be rammed through all runs. In addition a connection was made with the pressure line for frequent flushing.

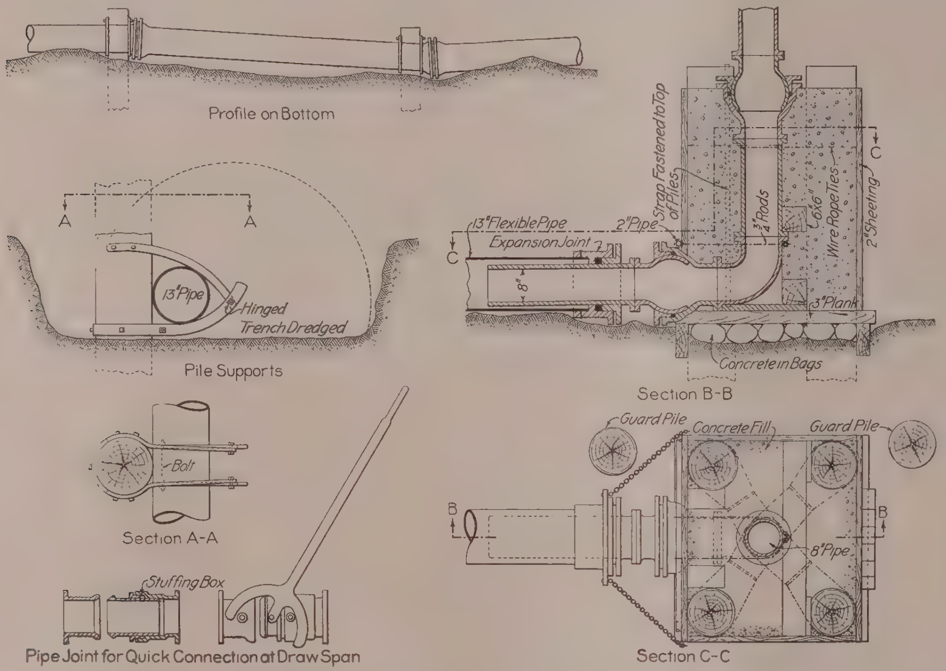
ADJUSTMENT OF FILTER OPERATION

The rate of filtration is controlled by rate controllers, but these were not accompanied by the necessary rate scales. Actual calibrations of scales were made for each filter based on counterweight setting. This was done in the usual way by closing the influent valve to the filter after the rate of filtration had become steady and timing the drop of the water level through a known cross-section, repeating this for several different settings of the beam counterweight. The results were plotted and the data for making the scales taken from this diagram. As the level falls the effective head on the controller also falls, and for the same rate of filtration the valve should open wider. To compensate for lack of uniformity of the rate of filtration during each test, readings of loss of head were taken every fifteen seconds and the initial rate calculated as indicated, or mean rate multiplied by the ratio of loss of head at the beginning of each test to the mean loss of head during the test. The results were plotted and the scales made from the mean curve. The scales were graduated to give the actual flow through each filter in gallons per twenty-four hours. The scales were made in a local shop.

The wash-water pressure was adjusted to give the maximum rate of wash consistent with non-disturbance of the gravel underdrains and loss of sand over the gutters. Adjustment was made at the valve of the wash-water pump, and check readings were taken on a pressure gage attached to the wash-water line. The rate of vertical rise was measured by closing the drain valve with the main gutter nearly empty and timing the period from the instant wash water began to overflow the lateral gutters until the pump was closed, which closing was done just before the main gutter filled. The time interval and measured fill in the gutter gave a fair idea of the rate of vertical rise, which ranged from 0.97 to 1.03 ft.

An inspection of the disturbance of the sand surface during washing and of the surface after wash showed that certain parts of the filter, different in different filters, were subject to violent eruptions and disturbance of the sand surface, and that at the end of a wash, while some areas were perfectly clean, others were covered by an appreciable mud scum. Furthermore, the distribution of air followed in a general way the distribution of the wash water. Still another feature was the great difficulty, in fact impossibility, of completely expelling the air used in washing by the wash-water pressure. Rough measurements of the vertical rise in each half of one of the filters showed a maximum difference of 16 per cent and a final turbidity of wash water in each half to be 1200 and 100 parts per million respectively.

In an effort to determine the cause of this condition the sand and gravel were removed from about 18 sq. ft. of underdrain surface and an inspection made. The laterals and the neck of the strainer cups were embedded in concrete and consequently no data on the degree of evenness of the laterals could be obtained, but the tops of the cups showed a variation in elevation of as much as ¾ in. On applying the air with the strainer system empty more air issued from the high cups than from the low cups. The wash-water jets followed the same variation. It was not practical to remedy this condition.



Details of Submerged Water Main with Flexible Joints at Richmond, B. C.

TRAINING THE OPERATORS

In training the operators and in explaining to them, the theory and practice of filtration were made as clear as possible in a non-technical way and the effects of various features of operation emphasized by exaggerated tests. The effect of soda ash was made clear by adding enough of this chemical to a heavily treated alum water to produce an immediate floc. The result of too much alum was shown by redissolving the floc by further addition of alum solution. The effect of sedimentation was shown by allowing the precipitate to settle. High rates of filtration and sudden changes of rate were made clear by exaggerating these conditions greatly and sampling the effluent.

A set of turbidity standards was made up and their use explained. These standards were made at the plant with very crude devices, yet the standards proved quite accurate. About three tablespoonfuls of Fuller's precipitated earth were added to a 2-gal. bucket of water and mixed. After two hours' subsidence about 1000 cu. cm were removed by immersing a bottle just beneath the surface and were then diluted slowly in a 5-gal. can of filtered water until a stock solution of 100 parts per million of turbidity, as measured by a candle turbidometer and checked against a turbidity rod, was obtained. From this stock solution the various standards were made by further dilution, using a small, narrow-necked bottle as the unit of measure.

In addition to the turbidity readings of raw water and effluent, tests of alkalinity were made by the operators and soda ash was applied accordingly. The lacmoid-sulphuric acid test was used for this purpose. With proper dilution the soda-ash solution was similarly tested.

A record form was arranged for keeping the operating data and for obtaining comparative results of operation as regards effectiveness and economy. As the operators were unaccustomed to numerical calculation, charts or diagrams were prepared from which most of the results could be obtained graphically. Some of the more useful of these were: A diagram giving raw-water discharge, knowing the rate of rise of level in the coagulation basins with outlets closed; a diagram giving the number of pounds of alum required to make up various per cent solutions to any depth in the tanks; a diagram giving the chemical orifice setting to obtain any desired rate of coagulant application; a diagram giving the quantity of water pumped by the high-lift pumps, the number of revolutions in any period of time, and a diagram giving the quantity of wash water used, knowing the duration of wash and the vertical rise.

In order to have the necessary information and instructions available in case new men were put on, these points were embodied in a lengthy typewritten form preceded by concise directions.

The Oregon Power Company, which operates the filters in conjunction with a power plant, is one of the properties of H. M. Byllesby & Company, of which Mr. Otto E. Osthoff is chief engineer and Mr. W. R. Thompson assistant chief engineer. The filter work was under the charge of Mr. J. W. Link, hydraulic engineer. Mr. C. G. Gillespie was employed for two months to put the plant in running order and train the operators.

Laying Submerged Water Main on Pile Supports

To convey the water supply of Richmond, B. C., across the north arm of the Fraser River there was laid in 1911 a 13-in. submerged steel main with flexible joints, having a length of 1200 ft. Richmond's water supply is furnished by the city of New Westminster and amounts to about 900,000 gal. daily. On account of the extremely uneven nature of the river bed, its continual shifting and the great number of water-logged trees and snags the pipe joints were not able to withstand the strain upon them and leakage finally increased to such a degree that it was impossible to maintain the required pressure. It was recently decided, therefore, to raise the 13-in. main and relay it on a level, protected support in the bed of the river.

PIPE CONNECTION AT DRAWSPAN

In order to maintain Richmond's supply in the meantime an 8-in. wood-stave pipe was laid across a bridge at floor level. This necessitated arrangements for stopping the flow when the draw was opened. After drawing up tentative plans for joints of several types to be used at the drawspan connections, it was decided to use a device which had formerly been successfully employed on drawspan connections on a 2-in. main. This device consists of three brass castings, as shown in the accompanying drawing, one of which is movable and actuated by a hand lever. The movable part works through a stuffing box, its tip being machined to a cone shape which exactly fits the opposite casting so as to make a tight joint; the parts are spherically ground. In case the drawspan settles and the closure is slightly out of its normal position the cone shape of the connection brings the two ends of the pipe into line. This joint has been in use about six months and is said to have given excellent service without requiring repairs of any kind. The drawspan is opened on an average of about fifteen times a day.

In order not to subject the pipe to water ram by the too sudden closure of the valve on the reservoir side of the draw, a blowoff is provided which discharges into the river. When the drawspan is to be opened the full flow of the main is first turned into the river, after which the valve between the blowoff and the drawspan joint can be closed with ease. The total length of the 8-in. wooden main on the bridge is about 450 ft., and it has been found that the insertion of this length of smaller diameter pipe in the 2½-mile length of 13-in. line has reduced the capacity only very slightly, as the principle of the Venturi-meter tube serves to increase the velocity through the smaller section. This 8-in. wooden main with the drawspan connections will be left in place as an emergency reserve after the new submerged main is in use.

BRACKETS FOR SUBMERGED MAIN

In preparing to relay the 13-in. main it was decided to use an agitator-suction dredge to excavate a trench directly across the bed of the stream. To insure further the rigidity of the pipe piles were driven in this trench 16 ft. apart provided with metal brackets for clamping the pipe to the pile at the level of the trench bottom. In designing the bracket the requirements called for strength sufficient to carry the weight of the pipe to the pile if the river bed should scour from beneath and a fastening device capable of easy adjustment by a diver. The bracket used is so shaped, as shown in the drawing, that should the pipe settle on it slightly out of line the curve of the bracket would guide it against the pile, after which the upper arm would be swung into the closed position and spiked by the diver. The piles averaged 50 ft. in length and were driven about 11 ft. below the bottom of the channel. The brackets were affixed on the upstream side of the piles before driving, and in order that all might have the same level after the piles were driven a level instrument and observer were placed at a convenient point and driving was stopped when marks previously placed on the piles were down to correct elevation.

Troubles with River Current

While the piles were being driven the pipes had been bolted together and were supported on the under side of a long raft. When the row of piles was in place this raft was extended from shore on the upstream side. It was found, however, that the river current, which had a velocity of about 4 miles per hour, held the raft so firmly against the piles that it was required to use a tug, steaming full speed against the broadside of the raft, to free it from the piles. After considerable difficulty the raft was moved into place and the pipes were filled with water.

Chain pulleys had been provided to ease the pipes down to their supports, but the current held the pipe so firmly against the piles that it was even necessary to weight it down with bags of sand before it would sink. When it had sunk about 2 ft. an obstruction was found at the south end. It proved to be a two-armed snag that had come downstream during the night and encircled one of the piles; this was removed by the tug. Although only four and one-half days elapsed between dredging the trench and laying the pipe, soundings over the pipe disclosed the fact that the channel had silted up at the extremities of the trench to a depth of 4 ft., and the pipe was this far above the brackets on the piles at these points. This was not considered serious, however, as the brackets lie open beneath the pipe, and any scour of the river bed can only let the pipe down on its supports. After the pipe was lowered into the trench, the piles were cut off level with the river bed.

Because of the reduced pressure on bends, and because the full 13-in. section was not deemed necessary for the required delivery, the vertical pipes at each end of the submerged main are 8-in. in diameter instead of 13-in. The bends are anchored in concrete, supported on four piles, as shown in the drawing.

A crew of ten men was employed in transferring the main. Navigation to points up the river was stopped for four days. The work of relaying the submerged main was done by the city of New Westminster, under the personal supervision of Mr. J. W. B. Blackman, city engineer.

Progress of the San Diego Panama-California Exposition

At the present rate of construction the fifteen main buildings, bridges, dams and landscape features of the Panama-California Exposition at San Diego will be completed by July, 1914. The 1400-acre site of the fair is in Balboa Park, 1½ miles northeast of the center of the city, on the heights overlooking San Diego Bay and the ocean. The layout has been designed to provide the city with an elaborate park and artistic buildings after the fair, which will last a whole year, beginning Jan. 1, 1915, has closed.

Balboa Park is situated on a level bench of land cut up by several ravines running from north to south. These slopes of land have been used to foster a beautiful natural garden, which is being set out by the fair officials. At present the gulches are dry, but it is intended to dam them up at convenient spots and produce a chain of artificial lakes. All level land is being utilized for the boulevards and buildings, about 1000 men being at work in various parts of the grounds.

The fire-protection and water-supply system, comprising about 6 miles of 4 to 30-in. pipe, is 75 per cent finished. All underground conduit systems and sewers are complete.

The most spectacular feature of the work is the reinforced-concrete viaduct spanning Cabrillo canyon, which is 136 ft. deep and 1010 ft. wide. This structure consists of seven concrete arches supported on concrete piers carried down to bed rock. At present two spans are in place, as well as the east abutment, making 33 per cent of completed work. This work is carried on by force account under the direction of the exposition engineers.

Buildings for exhibits of home economy, arts and crafts, science and education, commerce and industry, agriculture and horticulture and the southern California counties are practically finished, with the exception of the staff work. A contract has been let and ground broken for the California State Building, which will be a permanent structure. Its cost is estimated at $242,000. The hospital and service buildings are permanent structures and have been in use for several months. The foundation for the machinery building has been started.

Private corporations have taken up an area of 6 acres for individual exhibits, the largest of which are the International Harvester Company, the Standard Oil Company, the National Cash Register Company and the Santa Fé Railroad. Ground is being broken for all of these companies with about 200 men at work. Plantation work is being forced rapidly. About 500,000 trees, shrubs and plants have already been set out in the park, and a large nursery, partly covered with glass, is used to propagate about 2,000,000 more. This nursery covers 120 acres of land. Giant palms and trees are being hauled about the grounds by motor trucks and transplanted in advantageous positions.

Artist's Sketch of Balboa Park Exposition Grounds, Showing Reinforced-Concrete Viaduct Spanning Cabrillo Canyon

Grading and leveling are 50 per cent completed for the amusement section of the fair, fronting on the Isthmus, which stretches out to a length of 4000 ft. north and south.

The main boulevard, the Prado, about which the principal buildings are grouped, is 4000 ft. long and connects the east and west entrances. It is graded and open to traffic, but not paved. Plants and trees are being set out around these boulevards and paths at the rate of 2000 per day.

Already the model farm exhibit of the counties of Southern California is complete. This exhibit contains more than 700 of the finest two-year-old citrus trees, a deciduous grove and gardens, and covers nearly 25 acres. The entrance is through a main building devoted to exhibits from the six counties, and is being built at a cost of $80,000.

Surrounding the entire exposition grounds is a wire-net fence, 8 ft. high, along which have been planted fast-growing shrubs and flowering vines, which will eventually cover the whole fence to make an effective border for the grounds.

Mr. Frank P. Allen, Jr., is director of works and Mr. J. A. Chase is engineer and superintendent of construction.

Subway Tunnel under Harlem River

Four-Track Steel-Tube Structure Assembled and Riveted Near the Site and Floated, Sunk and Concreted in Dredged Trench

Section 14 of the Lexington Avenue Subway in New York City is a four-track structure, 2630 ft. long, extending in the line of Lexington Avenue from 129th Street, Borough of Manhattan, to Mott Avenue, Borough of The Bronx. At the Manhattan end the structure has a rectangular cross-section about 50 ft. wide, 40 ft. high and 20 ft. in the clear below the surface of the street. The two pairs of double tracks are arranged in two stories. The subway is built of steel beams and columns, with concrete walls, roofs and invert.

CROSS-SECTION AND METHOD OF CONSTRUCTION

Going toward the Bronx end the cross-section rapidly changes to conform with the rearrangement of tracks, which diverge in horizontal and vertical planes, making the structure wider and shallower as the tracks approach the uniform level, which they attain at the entrance to the Harlem River tunnel, where the structure is 70 ft. wide and 20 ft. high, with the roof nearly 30 ft. below the surface of the ground. At the Bronx end of the tunnel the cross-section has similar dimensions, but soon widens into two divergent double tracks, each about 600 ft. long. One of them, on Park Avenue, has a rectangular cross-section about 40 ft. wide and 22 ft. high, with the roof about 20 ft. below the surface of the ground.

The other branch, on Mott Avenue, has a cross-section about 45 ft. wide and 21 ft. high, with a roof composed of two intersecting arches supported in the center on a partition wall. The construction consists of reinforced concrete floors, and steel beams and girders incased in concrete jack arches form the sidewalls and roofs throughout, except for the arch portion, where the arch will consist of cast-iron segments lined with concrete. The floor, side and center walls of this arch section are of plain concrete.

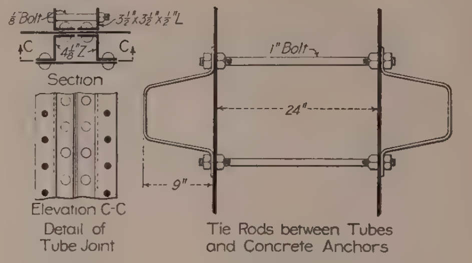
The tunnel section, 1,080 ft. long, consist of four parallel riveted steel tubes 19 ft. in diameter inside and 17 ft. apart on centers, with their axes in the same horizontal plane. The tubes are lined with concrete and are inclosed in a mass of concrete 76 ft. wide and 24½ ft. deep, with the upper surface at an average depth of about 32 ft. below mean high water.

The essentials of design and proposed method of construction correspond with those of the 2,625-ft. double-track tunnel under the Detroit River, which has two steel tubes 23 ft. 4 in. in diameter inclosed in a mass of concrete, 58 ft. 8 in. wide, in a dredged trench about 80 ft. below the surface of the river, as described in the Engineering Record of December 18, 1909, page 678. These tunnel-construction methods were executed under the direction of Mr. Olaf Hoff, who is also a member of the contracting firm building the Harlem River tunnel.

STEEL TUBES

The steel tubes are riveted up complete, four abreast, on the longitudinal caps of four lines of falsework piles driven in a slip in the Harlem River about 1 mile from the tunnel site. They are successively constructed in three duplicate intermediate sections, A, B, and C, each 220 ft. long, and two end sections, E, 199 ft. long, and D, 219 ft. long, which will be fabricated and sunk in the sequence of lettering. Except for 44 ft. at the Manhattan end, where it is curved to a radius of 2,000 ft., the alignment of the tunnel is tangent horizontally from end to end. Vertically it has two curves connecting an intermediate grade of 0.3 per cent with grades of — 3 per cent and + 3 per cent.

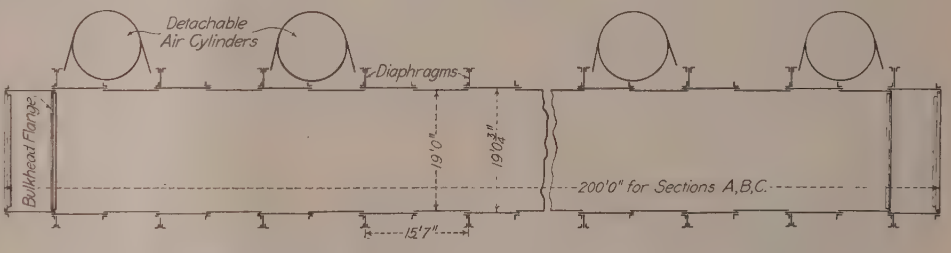
The tubes are made of steel plates ⅜ in. thick and generally 7 ft. 9½ in. long, parallel to the tunnel axis. The adjacent sides of the tubes are flattened and have vertical walls about 11 ft. high and 2 ft. apart in the clear. Circular-flange angles are riveted to the exterior of the tube 7 ft. 9½ in. apart, and alternate ones are riveted to exterior vertical transverse plates ¼ in. thick, which have butt joints spliced together with single cover plates. Together they form continuous diaphragms 24½ ft. high and 76 ft. long, pierced by the tunnel tubes and stiffened at their outer edges by pairs of flange angles.



Detail of Tube Joint

Tie Rods between Tubes and Concrete Anchors

Longitudinal and Transverse Tube Connections



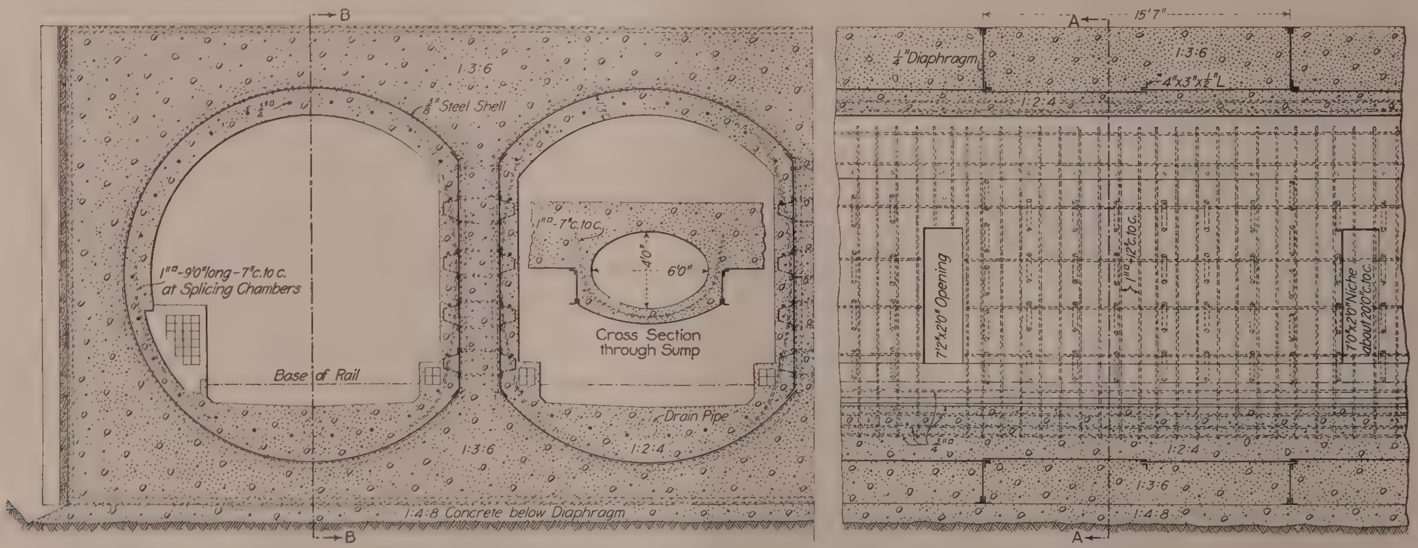
Longitudinal Sectional Elevation of Tubes with Air Cylinders Attached

Intermediately between the diaphragms the adjacent vertical walls of the tubes are connected by 1-in. horizontal bolts, and U-straps engaging them project from the opposite faces of vertical walls to bond and anchor the vertical concrete wall lining.

Near the middle of the tunnel a rectangular extension 7 ft. 9½ in. wide and 24 ft. 9 in. long transverse to the tunnel axis projects about 4 ft. beyond the bottom of each pair of tubes and is lined with concrete forming a sump with a 4 x 6-ft. oval cross-section and a length of 33½ ft., accessible from each tube through a manhole 3 ft. in diameter. The lower edge of the sump box is 1 ft. below the bottom flanges of the main transverse diaphragm. Cast-iron drain pipes 12 in. in diameter are laid on the center lines of the invert and discharge all drainage to the sumps.

CONSTRUCTION JOINTS AND POCKETS

At each end of each section of the tube there is an exterior circular flange angle and an interior circular flange Z-bar, with the inner face of the latter punched to receive bolts in a circular cover splice plate assembled

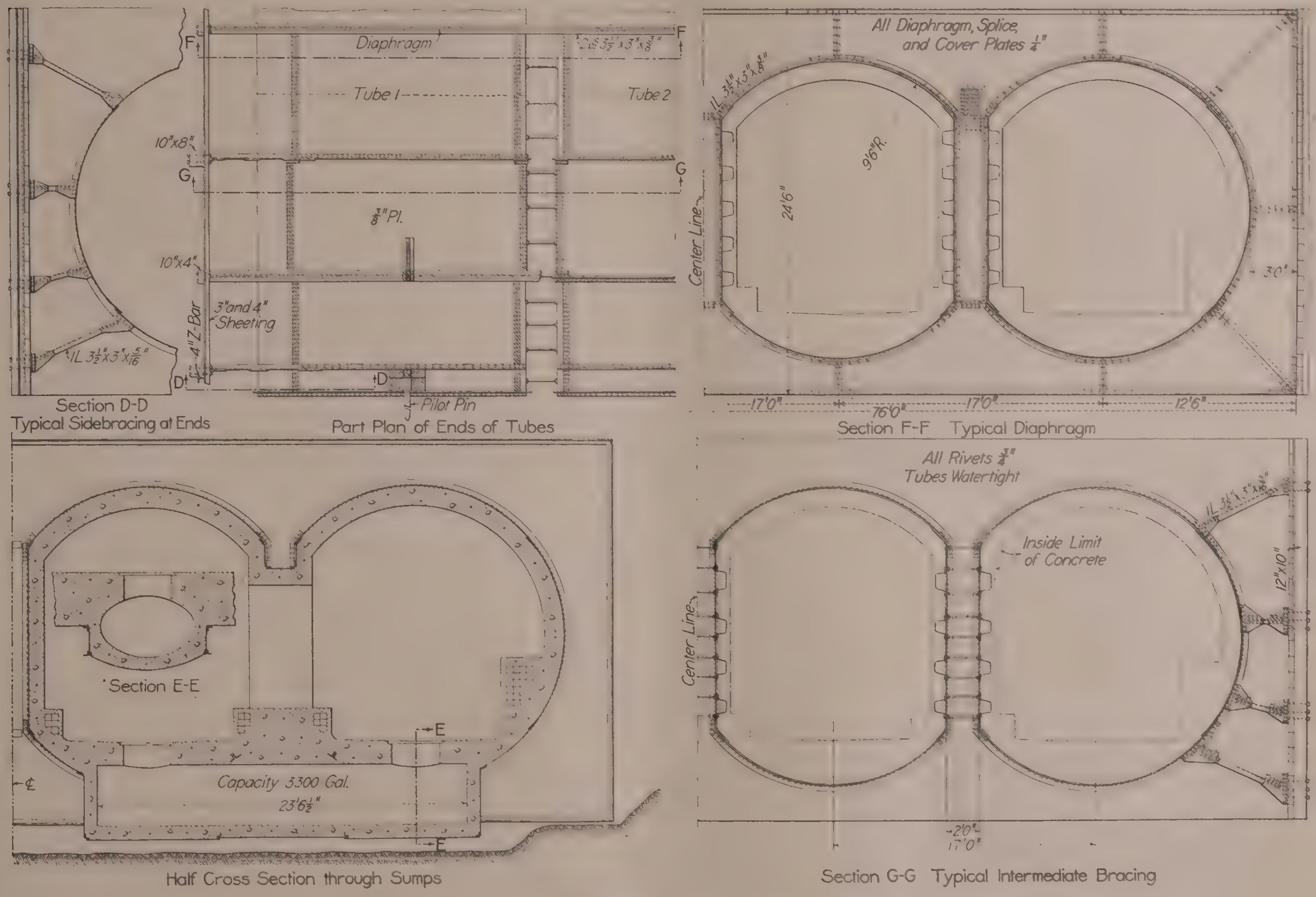


Section A-A

Section B-B

Part Transverse and Longitudinal Sections through Tunnel, with Pockets Concreted and Tubes Lined after the tubes are sunk to connect the adjacent ends. The projecting legs of the outside flange angles are punched for horizontal connection bolts, which are inserted and adjusted by divers.

A casting is riveted to the upper part of each outside tube at one end of each section and is bored to receive a long horizontal pilot pin which engages a tapered hole in a corresponding casting riveted to the adjacent end of the next section. As each successive section is sunk in the trench these pins guide them to proper alignment with the previous section and are keyed to lock them in required position on the prepared supports.



Details of Steel Tubes, Diaphragms and Bracing, with Outlines of Concrete and Pocket Sheeting

Near the end of each tube there is an inside circular flange angle which affords bearing for temporary horizontal bulkhead planks, closing the tubes when they are launched and floated. At intermediate points similar bearings are provided for semi-transverse bulkheads in the upper part of the tubes, which serve as air traps or curtains to steady the sinking.

Pocket Walls

To the vertical flanges of the main transverse diaphragm are bolted permanent horizontal planks forming longitudinal walls on both sides of the structure. These walls with the transverse diaphragms make rectangular pockets, which will be separately filled with concrete, entirely inclosing the tubes. At one end of section D each tube is provided with a vertical airshaft, 3 ft. in diameter and 4 ft. long, riveted to the top of the tube and having its upper end closed by a bolted cover plate, which may be removed if necessary for the connection of an entrance shaft.

All of the plates and angles are cut and punched ready for riveting at the bridge shop and shipped separately to the site, where they are assembled, and when completed the entire section is lifted and floated out on pontoons. The pontoons are then removed from under the structure and the tubes are sunk to position in the dredged trench, connected and inclosed in concrete, and deposited under water through tremies installed on scows.

The principal quantities involved in the tunnel are 6,094,000 lb. of structural steel, 50,000 yd. of concrete, 325,000 yd. of dredging and 300,000 ft. of timber, board measure. The contract price for the tunnel section, based on the estimated unit quantities, is about $1,620,000.

The work is being executed under the direction of the Public Service Commission, of which Mr. Alfred Craven is chief engineer and Mr. Robert Ridgway engineer of subway construction. The Arthur McMullen & Hoff Company is the general contractor, with N. R. Melvin as superintendent.

Development of Water Power with Federal co-operation has received further encouragement. The National Government has granted to the State of Oregon the sum of $15,000 with which to carry on investigations for an interstate water-power project near The Dalles, on the Columbia River. This makes the total amount of money appropriated for water-power investigations in Oregon $30,000, the State having previously appropriated $15,000. A preliminary report of the State indicates the feasibility of a large power development in conjunction with the proposed irrigation of several thousand acres in the Columbia River Valley.

Compensation for Street-Railway Use of Highway Bridge

A recent act of the Legislature of the State of New Jersey authorizes the Board of Public Utility Commissioners to direct a street-railway company to lay and operate tracks across a public bridge when such use of the bridge is a public necessity, and entitles the board to fix a period of time for such use, and the annual compensation, if any, to be paid by the street-railway company.

Under this act the board has directed the Public Service Railway Company to operate its cars over the Clay Street bridge betwen Essex and Hudson Counties. Under date of Sept. 29 the board issued an order fixing the annual compensation to be paid by the street-railway company in equal amounts to the two counties owning the bridge. The report contains a statement of the conditions and an analysis of the considerations by which several items comprising the amount of compensation were fixed.

Compensation, Past and Present

Under contract with the freeholders the street-railway company had paid $600 a year for the use of the structure formerly occupying the site of the present bridge. When the latter was completed terms for its use could not be agreed upon and it was not used by the railway company for a period of six years or more. The company being directed to lay its tracks across the bridge, submitted a brief proposing to pay $150 a year for its use.

A brief submitted in behalf of the freeholders of the counties of Essex and Hudson fixed the compensation at $6,528.78. The board interpreted the statute to allow the compensation to be fixed in accordance with the public outlay imputable to the use of the bridge by the street railroad company. It held that the compensation to be fixed under the statute is not identical with the total annual value of the use of the bridge to the company, but with the annual cost of the bridge to the counties by reason of trolley service thereover. The cost of the bridge was $178,474, and it was estimated that a bridge at the same site to carry trolley traffic alone would cost approximately $100,000.

Investigation of Trolley Service

A number of engineers, including Mr. Henry W. Hodge, Mr. James Owen, Mr. Otis E. Hovey, Mr. J. J. Yates, Mr. G. H. Pegram, and Mr. C. C. Sunderland, testified concerning the strength of the bridge, its probable life, the extra cost of providing for trolley traffic over it and the probable effect of trolley traffic on the life of the bridge and its maintenance cost. Apparently the engineers did not prepare exact estimates.

There was a wide variation in their opinions of the extra cost involved in making the bridge capacity adequate for highway and trolley service instead of for highway service alone. The evidence as to whether subjecting the bridge to the use of trolley cars will shorten its life, and if so to what extent, was "sharply conflicting." Several witnesses maintained that the trolley service would reduce the normal life of the bridge from about fifty years to forty years or less; other witnesses positively maintained that the trolley service would not reduce the life at all.

The board ruled that in consideration of the present condition of the structure the present expectation of life is forty-one years from date on the assumption that there is no trolley travel over the bridge.

Extra First-Cost Changes

After balancing the testimony and analyzing the conditions the board assumed that the trolley service would shorten the life of the bridge by a period of six years from date, leaving thirty-five years as the approximate probable future service life of the bridge, carrying the extra burden of trolley cars. The original extra public outlay for the construction of the bridge to provide for trolley service was fixed at $30,000, and the company was ordered, as a first item, to pay the annual interest charge. Moreover, in order to produce $30,000 in the thirty-five years of future life, approximately $407.32 per year at 4 per cent compound interest is required as a depreciation charge, and this likewise the company was ordered to pay.

Depreciation and Maintenance Charges

The present worth of the bridge, without trolley use, was computed on the basis of original cost to be $147,600, which for a life of forty-one years will be diminished $3600 per year. For a life of only thirty-five years, as estimated for trolley service, the diminution is $4217.14, the difference being $617.14, which was fixed as an annual compensation for shortened life.

The added cost of maintenance due to structural repairs, exclusive of pavements, that will be due to trolley service was estimated at $420 a year. The sum of these different items—interest on extra first cost, sinking fund on this cost, shortened life, and maintenance—amounts to $2644.46, which is the amount of compensation which the board ordered the railway company to pay for the use of the bridge.

Care of Streets in Chicago

Abstract of a Report on a Constructive Investigation of Cleaning and Repairing Streets and the Collection of Garbage and Wastes

Following the investigation of the collection of garbage and wastes and street cleaning methods in Chicago last winter by the efficiency division of the Civil Service Commission, as reported in the Engineering Record of Jan. 4, page 24, came a request to co-operate in the installation of the standards and uniform schedules proposed, inasmuch as appropriations were made in accordance with the recommendations. Shortage in revenues prevented the complete accomplishment of all these innovations, but study of the problems was continued for three months in 1913 jointly by the Civil Service Commission and the commissioner of public works.

A voluminous report, containing seventy-seven recommendations, many of them put into effect as the work progressed, has recently been rendered. The matters considered were street cleaning, garbage, ash and rubbish removal, distribution of street-repair funds, sidewalk care and construction, and administrative problems, equipment and records.

Methods Pursued

The procedure adhered to throughout the study was to ascertain administrative problems, organization and equipment, conditions, methods and systems employed and results obtained; to apply underlying and attainable standards and to determine the extent and relative virtues and defects of existing administration, organization, equipment, methods and systems; to provide constructive recommendations and to co-operate with departmental officials in correcting ineffective and inequitable methods, and to secure and maintain effective, sanitary and economic administration of these municipal functions.

Investigation has been pursued by research and analysis of all bibliographical, statistical and general information and data appearing in publications of scientific and public institutions and given by experts on these subjects; also through the medium of written inquiries directed to private and public officials and larger municipalities in this country and Europe and by personal inquiry made by the technical staff and the special corps of investigators and examiners.

A technical board comprising three members of each body was appointed to ascertain the amount, character and physical condition of all pavements in the city; to establish standards of street cleaning for different pavements under varying conditions, the best methods of cleaning each kind of pavement, and a standard day's work for each street laborer; to prepare and try out schedules for the cleaning of each mile of improved streets in the city; to determine the factors which control the kind and frequency of cleaning any pavement and base thereon a mathematical formula for uniform cleaning.

The report contains an estimate for the year 1914 for the upkeep of all improved streets and alleys based upon a unit maintenance cost according to the classification made of all such pavements as to kind, age, condition and traffic. In order that this might be done a traffic census was taken at 1320 points in the city of Chicago, and that compared with traffic counts taken in 1912 and previous years, for the purpose of showing changing conditions.

Last year in making up the budget the commission assumed employees averaged 63 per cent of the perfect standard of work. This year the average is raised to 74.4 per cent of the 85 per cent attainable, the highest per cent it is reasonable to expect of the average good and able employee.

Time Studies

Analysis of the records obtained from time studies disclosed that a proportion of men now assigned to sweep and clean the city's streets have no notion of the principles of doing their work effectively, with minimum waste of time and energy.

It was ascertained that there are at least thirty-eight distinct motions which a street cleaner makes in street-cleaning work. Of these some were found to be unproductive, resulting in loss of time and energy and less effective street cleaning. The most important of these are considered in the following:

Observation of the time spent in wheeling pushcarts into alleys or to other temporary dumping places disclosed that practically one-fifth of the time was consumed in this activity.

The studies disclosed that some sweepers are more efficient than others, due to the stroke of the broom which they make. The practice of hitting the broom on the pavement at the end of each stroke should be stopped, as this motion is not necessary on dry pavements and very seldom required on wet pavements. Effective and practical street cleaning can be obtained by bringing the brush down forcibly at the beginning of each stroke, thus reducing the work at least 15 per cent.

Time lost by street cleaners in dodging horses and automobiles where traffic is dense is unappreciable and does not exceed 8 per cent of the total time in the central loop district and not more than 2 per cent of the total time in outlying business streets. It is occasioned more through the congestion of traffic than through density of traffic.

In the studies of the methods used in cleaning light-traffic asphalt pavements it was found that after the morning thorough cleaning three-fourths of the area to be covered during the remaining part of the day does not require thorough cleaning.

Division of Work

Work done in gangs was not as economical as the division of such work through individual assignments. Considerable time is lost in conversation; when one man rests, every other man on the street does the same. The good sweeper does no more work than the poorest of the gang. Where it is desired to cover a large area of street with men working in groups, rather than in gangs, it would be better that each man be given a definite uniform area to cover and require the foreman to time each individual.

Street cleaning standards and factors followed closely methods pursued last year. The traffic census obtained on the 1400 intersections indicates that within the last three years the number of auto-driven vehicles in the central portion of the city has increased over 300 per cent and that the number of one and two-horse vehicles throughout the city has remained practically constant, while the number of three or four-horse-drawn vehicles has become practically negligible when compared with the number of one and two-horse vehicles.

Minimum cleanings of streets per week have been materially increased and so has the efficiency of the men.

Standard Daily Cleaning Areas

From an analysis of the time studies of the work of street cleaners, definite data have been secured upon which is based the relative difficulty of cleaning the different kinds of pavements with varying physical conditions. The standards and equivalent areas which it is assumed can be cleaned by one man in one eight-hour day follow:

Pavement	Condition of pavement	Standards	Equivalent sq. yd.
Asphalt	Good	100 per cent average perfect standard	34,000
Asphalt	Good	85 per cent attainable standard	28,900
Asphalt	Good	74.4 per cent of attainable standard assumed for 1914	21,500
Asphalt	Fair	90 per cent of good asphalt..	19,300
Asphalt	Poor	80 per cent of good asphalt..	17,200
Creosote blk.	Good	Good asphalt	21,500
Brick	Good	Good asphalt ÷ 1.35	16,000
Brick	Fair	63 per cent of good brick....	10,000
Brick	Poor	50 per cent of good brick....	8,000
Granite	Good	Good asphalt ÷ 1.60.........	13,400
Granite	Fair	75 per cent of good granite..	10,000
Granite	Poor	60 per cent of good granite..	8,000

Analysis of the data also indicates that the presence of car tracks in a street increases the difficulty of cleaning the street, and that under similar conditions the street-car right-of-way is approximately 15 per cent harder to clean than the pavements outside of the car tracks. In instances where the pavement of the right-of-way has been found to be different from the pavement of the remainder of the street the area of the right-of-way has been increased by 15 per cent and the paving factors applied.

With definite and uniform standards of records and cost keeping adopted by the larger cities of the country a closer means of comparison of unit costs will undoubtedly be found, the difference depending wholly upon the difference in standard of cleanliness maintained. In Chicago the average cost of cleaning 1000 sq. yd. of pavement by hand, exclusive of overhead charges and interest on the cost and depreciation of equipment, was 42 cents during 1910, 36 cents during 1911, and 37.7 cents per 1000 sq. yd. during 1912. This includes the cost of all the different methods of street cleaning and the cost of disposal of the street dirt. The cost of street flushing averages approximately 14 cents per 1000 sq. yd.

Street Repairs

In connection with the field investigation of the cleaning of all streets and alleys, special study was made of the factors and conditions which control the repair of improved pavements. It has been found that the cost for the maintenance and repair of pavements varies directly with the amount of traffic and the area and condition of pavement.

The traffic census on different streets having permanent pavements and other information as to character of different districts of the city have been used as a basis for placing the different wards of the city in four groups, group 1 having the heaviest traffic.

Within these groups definite variations were found in the cost of maintenance of improved pavements, depending upon whether these pavements are on heavy traffic streets or non-traction streets but not main thoroughfares, or on light traffic streets.

The unit maintenance cost for the different pavements have been found to vary with the kind, age and condition of each improved pavement. Analysis of the records of the Bureau of Streets and of the Board of Local Improvements furnished figures as to the average unit cost. The unit maintenance cost which has been used for each kind of permanent pavement and the weights which were used for the different groups of wards and streets within groups are as follows:

Brick and Creosote Block Pavements

Group	Weights	Traction streets 2	Through-route streets 1½	Light-traffic streets 1
1	2.5	9.4c	7.0c	4.7c
2	1.5	5.6c	4.2c	2.8c
3	1.0	3.72c	2.8c	1.86c
4	0.75	2.8c	2.1c	1.4c

Granite Block Pavements

Group	Weights	Traction streets 2	Through-route streets 1½	Light-traffic streets 1
1	2.5	7.0c	5.25c	3.5c
2	1.5	4.2c	3.15c	2.1c
3	1.0	2.8c	2.1c	1.4c
4	0.75	2.1c	1.575c	1.05c

Asphalt Pavements

Group	Weights	Traction streets 2	Through-route streets 1½	Light-traffic streets 1
1	2.5	10.0c	7.5c	5.0c
2	1.5	6.0c	4.5c	3.0c
3	1.0	4.0c	3.0c	2.0c
4	0.75	3.0c	2.25c	1.5c

Macadam Pavements

Maintaining macadam, exclusive of oiling and screening, per sq. yd.	$0.0225
Oiling, per sq. yd.	.02
Screening, per sq. yd.	.028
Resurfacing cedar block pavement with crushed stone, per mile	6000.00

The unit maintenance cost which has been used in estimating the repair and improvement of the 55 miles of country roads is $750 per mile. This amount will not be sufficient to repair and improve the entire area of country roads, but will take care of the most necessary repairs.

Motor Trucks

Tests have been made during the past year on the use of motor trucks for hauling crushed stone and material for the street repair work. It was found that the conditions are generally favorable to the use of motor trucks, as the time required to load and unload is relatively small, the travel of the truck is confined almost entirely to streets, and the maximum length of haul was within the province of electric trucks.

Analysis of the estimates show that the use of motor trucks is more economical than horse-drawn vehicles when same are used for a period of at least 300 days per year in the transportation of crushed stone, asphalt and other street repair materials. If the period in which the transportation equipment is used is less than 180 days each year, which is the minimum period in which street repair work will be made during any year, the use of horse-drawn asphalt wagons is more economical and the use of horse-drawn wagons for hauling crushed stone is less economical than any type of motor truck. Further the report states that in order that the cost in using electric trucks instead of asphalt wagons be equalized, the electric truck must operate at least 230 days each year and the gasoline truck must operate at least 260 days each year. Under favorable conditions, the motor trucks would be more economical than horse-drawn vehicles for the transportation of crushed stone and asphalt, and the use of electric trucks will probably show a saving of approximately 25 per cent. The repair division of the Bureau of Streets could use to good advantage such modern equipment and an appropriation for at least two 5-ton trucks is recommended.

Planning Section

On account of the division of authority and overlapping of duties it was recommended that the bureau of sewers, bureau of compensation and bureau of streets be combined. One of the new sections suggested was that of engineering and planning. In order that service and work be maintained uniformly throughout the city and the appropriations be expended in accordance with definite and uniform methods, it will be necessary to continually check changing conditions and the work being performed in every section of the city. The growth and the importance of the activities of the street bureau within the last ten years have been such as require constant planning and technical analysis of conditions existing throughout the city.

Therefore, provision should be made for a staff of technical assistants, under a planning engineer, who shall study conditions, methods and work in the different sections of the city and assist their superiors and the ward superintendents in maintaining uniform service and methods throughout the city. They will be able to furnish the central office with information on the effectiveness and economy of the service rendered, act as inspectors on complaints received at the central office and perform such other technical and engineering duties as may be required in carrying on the work of cleaning and repairing streets, alleys and sewers and the collection and removal of garbage and other wastes.

Effect of New York State Barge Canal on Commerce

The construction of the New York State Barge Canal has been proceeding for a number of years. Numerous doubts have been expressed as to the justification for this costly work. In the opinion of Mr. George Clinton, Jr., as set forth at the convention of the New York State Waterways Association, Oct. 30, the benefits that will be derived by the State and the country at large are many and far-reaching. These notes are taken from his paper.

The effects of the Barge Canal will be chiefly due to the great reduction in the cost of transportation which is certain to follow. This makes the situation analogous to that presented by the original construction of the canal. It has been figured that the actual cost of transporting a ton of freight over the Barge Canal between Albany and Buffalo will be 26 cents, making the cost per ton-mile about 0.52 mill. This estimate is probably too low, but the cost will be little if any above 0.65 mill per ton-mile. The cost of transportation in the present canal is about 0.80 mill per ton-mile, and by rail about 2 mills. It is understood that these figures relate to the cost of transportation and not to the charges actually made, which differ widely therefrom.

Other direct results of the opening of the Barge Canal will be the opening up of communication with other places, both in and out of the State, not hitherto commercially accessible. A striking example of this is to be seen in that part of the State which borders on Lake Champlain. With the iron ore and limestone which are very near at hand and the cheap coal which will be made available by means of the Barge Canal, the iron industry along the shores of Lake Champlain will, Mr. Clinton prophecies, develop tremendously. Furthermore, if the Atlantic Deeper Waterways Association's plan for intracoastal canals along the Atlantic coast should be carried out direct communication by barge may be had between all the Atlantic seaports and the cities bordering on the canal.

Among the direct results the most important, perhaps, is the fact that the cheap transportation to be afforded by the canal will place New York City in a position where it can successfully compete with other Atlantic seaports for the export trade in spite of the discrimination which has been exercised against that city by the through-railroad lines by means of differentials. This is a matter which concerns the whole State, and indeed the whole country, for cheaper transportation to New York of products coming from the West would necessarily mean a reduction in the rates for transportation to other seaports, and thus not only New York, but the whole country, would reap the benefit.

Another direct benefit to be expected is the increase in the use of the canal for local traffic. This use has of late years fallen off so that at the present time local traffic constitutes a comparatively small part of the business transacted upon the canal; but it is to be hoped and expected that upon the completion of the Barge Canal, with its low cost of transportation, its large and modern barges assuring safety to cargo and its freedom from annoying delays, merchants and farmers along the line of the canal will see the advantage of using it for the transportation of their goods. This may, perhaps, especially in the case of farm products, affect favorably the high cost of living.

Indirect Results

The foregoing advantages are surely great, and with them accomplished the wisdom of the expenditure made by the State for the construction of the Barge Canal would need no argument, but the indirect results which are to be anticipated are even greater and more far reaching. The first of these, and that which is most obvious, is the large increase of traffic which will unquestionably take place. Where a cheap trade route exists leading to a market where goods can be profitably sold, manufacturers will, other things being equal, naturally locate their plants on or near that route. The Barge Canal will presumably not only stimulate and thus increase existing commerce, but will create new commercial enterprises which themselves will greatly increase the traffic upon the canal.

This leads to the subject of new industries. The Champlain district is merely one instance of what may be expected to occur at different points all along the canal. With cheap coal from Pennsylvania and cheap ore from the upper lakes there is no reason why blast furnaces should not be established in the central portion of the State to great advantage, particularly as the third great requisite for that industry, limestone, is near at hand.

An important effect of the reduced cost of transportation on the Barge Canal will be the control of railroad rates. The Erie Canal, even at its worst times, controlled and still controls through-railroad rates from the West to the Atlantic seaboard by the threat of competition which its existence implies. That threat of competition will be much more effective in the case of a canal on which the cost of transportation is 0.65 mill per ton-mile than on the present canal, where that cost is 0.80.

For some years past the cities of Buffalo and New York have been losing the benefit of through shipments of grain for export from the West. Anything which largely affects New York City and Buffalo is felt throughout the State. A large part of this grain is being diverted to Montreal by the Canadian water route. The Barge Canal will bring it back.

The increase of the commerce, the building up of new industries, the increase in population and the existence of a cheap transportation route will largely increase the values of property lying along or near the canal, thus adding to the wealth of the State and the prosperity of its citizens.

To summarize, there may be expected as results of the opening of the Barge Canal cheap freight rates, the opening up of new trade channels, an increase in local traffic, the restoration of New York City's supremacy over other Atlantic seaports, lower railroad rates, increased population for the State, the building up of new industries within the State, a restoration of the through grain trade to Buffalo and New York and increased value of property on or near the canal.

Book Reviews

Principles of Industrial Organization. By Dexter S. Kimball, Professor of Machine Design and Construction in Sibley College, Cornell University. Cloth, 9½ x 6¼ in.; 272 pages; 19 illustrations. New York, McGraw-Hill Book Company. $2.50 net.

The object of this book, as expressed by the author in the preface, is "to set before young men entering the industrial field the salient facts regarding the most important movements with which they are sure to be brought into contact and to explain the origin and growth of the important features of industrial organization." The author has succeeded very well in the task he has set out to perform. The book is intended primarily for college use and has been held within a compass of 272 pages. It is evident, therefore, that the various subjects are not treated exhaustively. The salient points are well put, however, and will form an excellent groundwork for intensive study in any one of the many highly specialized fields into which industrial management has been divided. The work is based upon a course of lectures given to the seniors at Cornell University.

The subject is divided as follows: Fundamental and historical; the industrial revolution; effects of the great inventions; corrective influences; modern industrial tendencies; forms of industrial ownership; principles of organization—system, planning departments; principles of cost keeping; depreciation of wasting effects; compensation of labor; purchasing, sorting and inspection of material; location, arrangement and construction of industrial plants; résumé—theories of management.

Mine Surveying. By Edward B. Durham, Associate Professor of Mining, University of California. Leather, 5 x 7¼ in.; 391 pages; 211 illustrations. New York, McGraw-Hill Book Company. $3.50 net.

The first chapter assumes a general knowledge of surveying and summarizes briefly the information common to books on that subject, as to the use and care of instruments, the adjustments and general surveying methods. A chapter on the equipment for underground surveying follows. Underground traversing and surveying for details are discussed in the next two chapters, the author pointing out the various ways of adapting surface methods to the cramped conditions of the mine and the special requirements of a mine survey. He then explains the calculations and discusses the mapping, the importance of which he specially emphasizes.

Several chapters then follow on special mine surveys, special problems and special instruments. Steep transit sights and shaft plumbing are discussed at length, and a valuable chapter on tunnel surveys includes descriptions of the methods employed in various existing tunnels. The author closes with interesting chapters on surface and mine models, exploratory surveys and magnetic surveys.

The book is a valuable one for the surveyor of mines. The subjects are introduced in logical order. The text is large and clear, with ample side heads; the illustrations are good and the volume is neatly bound and of a convenient size.

Cranes and Hoists: Their Construction and Calculation. By Hermann Wilda. Translated from the German and Adapted to British Practice by Charles Salter. Cloth, 4¾ x 7¼ in.; 168 pages; 399 illustrations. London, Scott, Greenwood & Son. $1.25 net.

This book, which is Volume 6 of the "Broadway Series of Engineering Handbooks," is devoted to both the construction and the calculation of cranes and hoists. There are two chapters. The first, containing fifty-five pages, deals with the elements of lifting tackle, taking up in turn ropes, chains, pulleys and drums, and passing on to the more complex elements and attachments. The other chapter discusses the various types of cranes and hoists, and seems to cover them all.

The text is well supplied with side heads. Attention is paid throughout the book to the mechanics involved, a large number of formulæ being developed. As far as appearance is concerned, the illustrations are too numerous for the amount of text. They are small and rather crude, and on some pages so many are crowded that the eye is bewildered. The ground seems to be covered, however, and the book should prove useful to many.

American Railroad Economics. By A. M. Sakolski, Staff Lecturer in New York University School of Commerce, Accounts and Finance. Cloth, 5¼ x 7¾ in.; 295 pages. New York, The Macmillan Company. $1.25.

In this volume Dr. Sakolski has produced an admirable text book on railroad economics. The treatise will prove of value to the student, and being written largely from the viewpoint of the financial expert, it will afford assistance also to the investor who believes in testing by personal analysis the earning power, financial strength, and operating efficiency of the properties whose securities he may purchase. The author has drawn freely on his experience as an investment analyst, and his illustrations of principles by concrete cases are well chosen and effective.

The work, too, is well balanced. The task of condensing in one volume of 295 pages a discussion concerning such a wide range of subjects as are embraced in the economics of transportation was not easy. Yet Dr. Sakolski has touched upon all of the essentials and has developed the more important considerations in some detail.

The first chapter deals with the theory of rates, the regulating powers of the Commissions, and the problems which confront the traffic manager. The second contains a good summary and description of the various kinds of railroad securities. The third, which is one of the best in the book, sets forth the development of railroad systems, their financial affiliations and their geographical location. The tables show the mileage of twenty-five large systems having centralized administrative control, and the separate companies embraced therein. A brief description is given of a few of the more prominent ones.

Chapter 4 outlines the economics of railroad construction. Necessarily the treatment is brief and incomplete, but it is well summarized in non-technical language. This comment applies also to Chapter 5, which deals with the physical factors in economic operation. Emphasis is placed on an important truth which is to be borne in mind at this time when it is becoming so difficult for railroads to finance the work of enlargement and improvement of facilities, and when the railroads are being held to such strict accountability for efficiency. This truth is italicized on page 109: "A railroad company that is handling traffic beyond its capacity will undergo additional costs proportionately greater than the revenue gained by the extra traffic." In other words, when the trackage and terminal facilities of a railroad are overtaxed, the familiar law of increasing returns does not apply to further increases in traffic. Instead, the additional traffic causes a decreased rate of return on the whole business.

In some respects the author shows a lack of intimate knowledge of the physical units of roadway, structures, and rolling stock, but these slight blemishes (such as, for instance, those in the paragraphs relating to ties and ballast) do not detract from the value of the book, particularly the chapters which deal with accounting and financial factors and capitalization. The author is perfectly at home in his treatment of traffic statistics in Chapter 7.

The remaining four chapters of the book contain a comprehensive outline of the classifications of railroad accounts as prescribed by the Interstate Commerce Commission. The underlying principles are clearly brought out, and the income and profit and loss accounts are treated separately. Various methods are suggested by which the efficiency of operation may be tested, but the weaknesses as well as the value of these indices are pointed out. While devoting several pages to exposing the dangers which beset the operating ratio, Dr. Sakolski has himself stepped into one of its pitfalls in his conclusion (on page 209) that "the ratio of the cost of conducting transportation to operating revenues is, therefore, a good index of efficiency when not accounted for by changes in the rates or in operating conditions." Changes in the nature of the traffic—such as an increase in the percentage of low or high-grade freight—or in the proportion which the passenger revenue bears to the total revenues, or increases or decreases in the volume of gross operating revenue, as well as other factors which are beyond the control of the operating officials, may have as much effect, if not more, on the ratio as has the operating efficiency.

As a modern text book in courses on railroad economics in colleges the volume will undoubtedly have early recognition.

Letters to the Editor

How Not to Build a Retaining Wall

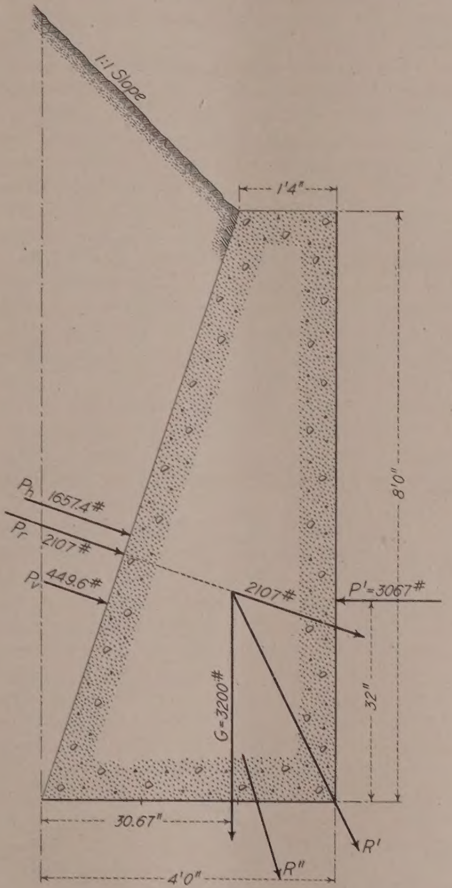
Sir: I noticed the article of Prof. L. E. Moore, entitled "How Not to Build a Retaining Wall," in your issue of Sept. 20, page 324, and observed at the time that the gravity line was off center, but as the conclusions regarding the stability of the wall with relation to the two positions were essentially correct I thought no more of the matter until I read Mr. Albert's somewhat caustic criticism of it on page 420 of the issue of Oct. 11. In the opinion of the writer this second article is more deserving of criticism than the first, as it contains a fallacy leading to erroneous conclusions. The writer, therefore, submits the accompanying diagram, illustrating what, in his judgment, is fallacious in the article of Mr. Albert.

In the diagram P_v is the normal component of the vertical force illustrated in Mr. Albert's diagram, and P_h is the normal component of the horizontal force. P_r is the resultant of these two forces. It is believed that the tangential components have no effect on the stability of the wall.

The forces P_r and G resolve themselves into R', which falls outside the toe of the wall, showing that for the forces mentioned the wall is in unstable equilibrium and would overturn.

Mr. Albert evidently neglects one important force in favor of the stability of the wall—that is, the friction of the material back of the wall with the wall.

The force R'' indicates the position of the resultant of the forces on the wall when the coefficient of friction of the earth with the wall is taken as 0.6667, an extreme condition purposely assumed to illustrate what might be considered a condition of maximum stability for the wall in this position.



It is evident from this that the wall is solely dependent on this friction for any stability at all. The thrusts assumed by Mr. Albert were used by the writer as a basis of comparison only. The writer figures that the pressure normal to the wall would be somewhat greater than that indicated.

Were the position of the wall reversed, as suggested by Professor Moore, a thrust of 3067 lb. would be required to throw the resultant to the outer toe, and there would still be the element of friction in favor of stability.

Greeley, Col. R. W. Gelder.

Sir: In my practice in designing plain concrete retaining walls and abutments I have observed the advantages of placing the batter on the front of the wall in preference to the back, as Prof. L. E. Moore has tried to demonstrate in his letters on "How Not to Build a Retaining Wall." This method, where feasible, has the advantage of placing the center of gravity of the vertical loads farther back from the toe of the wall and thus producing a larger "stability moment" than with a plumb, or practically plumb, face wall. This is particularly true in abutments carrying girder or truss spans, as the reaction from these spans with plumb face wall is usually not more than a few feet from the toe. Furthermore, with a plumb face the denser material is at the front and therefore brings the center of gravity toward the toe from the center of the base. On abutments I have used as much as 4 in. per foot batter on the front face and practically none on the back face where limitations of waterway or street width did not enter. When the area of waterway would be limited or span lengthened at street crossings, the extra length and expense of the bridge span would probably eat up all economy in the abutment, except, probably, where the depth of fill was considerable. In the case of retaining walls, however, there is seldom a case where the front batter could be made sufficient to be economical. Where the position of the toe is fixed and the fill is surcharged in back of the wall, the wall with an appreciable front batter has to be higher, and therefore becomes more expensive; but where the position of the toe is not limited this type certainly is much more economical for the same factor of safety.

Furthermore, if the surcharge is steep, the difference between the intercept of the fill, if allowed to run out, and the front of the wall is so small that no appreciable amount of space is gained in front of the wall. Of course, where the wall is built along a shore which is being eroded by waves, as appeared to be the case with the wall described by Professor Moore in his first letter, then the wall is built for protection instead of to gain space, and in such a case the wall with front batter seems to be the only kind to be used.

As may be inferred from the few notes mentioned above, each type has a place for itself and a designer should study all phases of the situation before deciding blindly on which type he will use, and probably should even try several types to be sure he has the right one.

Donald N. Becker,
Bridge Designing Engineer,
Chicago, Ill. City of Chicago.

Observations on Brick Pavement

Sir: The following observations are prompted by incidents at our recent annual meeting and by the letter from Mr. Mont Schuyler in the Engineering Record of Oct. 18:

First, there was no attempt in the inspection of streets and work in Cleveland to claim, for either the streets or the work, ideal conditions; there was no attempt even to show the very best streets. Our endeavor was to show streets such as they were, that had been long in service as well as streets in service for a less number of years; to show streets that were subjected to heavy, medium and light traffic; to show streets that were constructed in a manner involving the maximum cost, also streets involving the minimum cost.

It must have been observed that where an ample sand cushion was provided and compressed, and where a strong cement filler united the brick-wearing surface in a monolithic structure, the results were satisfactory. Nevertheless, we realize that according to the detail of refinement omitted in construction the pavement is ill favored, and that where all of the details are complied with as set forth in our "No. 1 Directions for Laying Vitrified Brick Pavement," regardless of age or use, no material defects whatever can be observed. We hold, therefore, the ideal is the best condition to strive for.

We regret very much that we were unable to show, as we had hoped to, a greater variety of construction details and a greater variety in methods of doing the work. This we were prevented from doing on account of two unforeseen incidents. The weather and the Perry celebration. On Wednesday we showed one contract under construction. The contractor was able to accomplish practically all of the details as required in his own way and somewhat differently than laid down in our "No. 1 Directions." We did have an arrangement interfered with as explained, where the application of the cement filler, as well as the proper method of compressing the sand cushion, was to have been shown.

We were able to show how readily and easily a concrete foundation could be made smooth, yet this demonstration was received as doubtful evidence of the same possible result if broken stone were used instead of gravel. We could only assure our friends that it was quite possible even with the use of broken stone to place a foundation with an equally smooth surface.

Mr. Schuyler's most excellent account of his own observations discloses a viewpoint that was quite possible to have been entertained by many. If so, a word or two by way of caution would seem entirely proper at this time. We refer to his suggestion of a possibility of "economical blunder in putting 65 cents' worth of good concrete under every square yard of brick pavement in any locality where soil conditions are similar to those found in Cleveland, where such beautiful streets have been down for ten years with no sign of failure."

This association does publish specifications, and advises such construction in very many places. We do this with considerable caution, especially with reference to drainage. If we could always be assured of perfect drainage—in other words, a condition of soil underneath the pavement free from moisture—there would be no reason or excuse for an artificial foundation of any kind, and brick pavement could be perfectly constructed without that added expense. Naturally a deep concern for the success of any pavement leads one to eliminate hazards and to include details of construction which tend to protect the integrity of the pavement against all possible conditions of climate and use for the longest period of time.

We believe that the details as laid down in our "No. 1 Directions" cover these possible hazards. The result attained by including all the directions is a pavement that never fails to meet enthusiastic praise and admiration.

Still another remark of Mr. Schuyler, to the effect that city engineers as a rule have very slight opportunities to examine the methods of other cities, leads the writer to conclude that perhaps there is some lack on the part of the specialist who is continually observing all conditions that affect his special work to make public his observations and conclusions with greater frequency. It may, therefore, not be amiss to state explicitly in constructive order the necessary and vital details which make most nearly perfect brick and block-stone pavements.

First, there must be a subsurface condition free from moisture—natural or artificial. If not natural or accomplished by drainage, it must be supplemented by an artificial foundation of concrete. In any event the natural soil condition must be brought to a thoroughly compressed state, affording a uniform support; and in either case the natural soil surface or that of the concrete foundation must be made smooth and brought to a grade conforming to that of the finished street.

The next requirement is that of a 2-in. sand cushion of uniform depth and equal density, a thorough compression of this uniform cushion cannot be accomplished except by rolling and refilling the depressions at least three times with a hand roller weighing about 350 lb.

This 2-in. depth can be compressed sufficiently to furnish a complete and uniform support to the monolithic structure of brick and stone, and yet afford a sufficient resiliency to relieve the shock that comes from the vibration of the impact. The support is sufficient to withstand the weight that comes upon the pavement. Such a condition protects against either shattering of the cement filler or breaking it with the weight of the load. The sand cushion thus prepared withholds the flow of sand in the open joints between the brick not more than is found necessary to bring the brick to an even surface by rolling after they are placed in the street.

Other functions of this sand cushion are to allow the movement of the wearing surface of brick and stone without obstruction—the movement from thermal influences so plainly brought out by Mr. J. E. Howard of the Bureau of Standards. [See Engineering Record, Sept. 27, page 345.] Relief from this creeping movement is obtained by placing a cushion along and next to the curb. The longitudinal expansion will be cared for either in compression, distribution or both. A transverse cushion is, therefore, not needed.

The brick must be placed in the street, with the best edge up in the first instance. They must be kept clean, protected from mud and dirt.

The application of the cement filler is one of the easiest steps in the construction of a brick pavement. It is only made difficult by the substitution of some methods or a use of material most unsuited for the purpose. Suffice to say the filler must be in place in proportion—that is, 1 of sand and 1 of cement. It must occupy the joints from top to bottom. Some so-called cement-filled brick-block or stone-block pavements have failed because the cement filler occupied only ½ in. of the upper portion of the joint. The filler should be permitted to set under influences developing its greatest strength—kept moist by a sheet of dirt or sand over the top, the sand cushion below having been slightly moistened when rolled. The rich mixture of Portland cement and sand is allowed to attain its best quality by such treatment.

Some writers inexperienced in brick-pavement construction feel that it is difficult to understand or difficult to execute. We hold to the contrary opinion, in proof of which we have frequently constructed pavements by using inexperienced and so-called green men for the work, organizing and proceeding with each step in a most satisfactory way without any difficulty whatever.

Will P. Blair,
Secretary National Paving Brick
Manufacturers' Association.
Cleveland.

Accelerated Pavement Tests

Sir: The making of accelerated tests in public, as was done at the American Road Congress at Detroit, you state editorially in your issue of Oct. 25 to be a mistake and that "the place, then, for accelerated tests is not in public, but in the calm, judicious atmosphere of the laboratory," and that its exhibition was "a violation of good engineering sense."

Forgetting for a moment the outcome, let us consider the attitude of the layman toward tests. Unfortunately it is possible to get expert engineering opinions on both sides of practically every question calling for settlement. No profession stands higher in the estimation of the public than civil engineering, yet until it becomes an exact science there will be differing opinions which leave the layman at sea. This is especially true in the comparison of paving materials.

If it were possible, then, so to conduct a test as to leave no loophole of doubt in the minds of competing manufacturers as to methods of completeness, and if the test could be so staged that the public could see the fairness of the comparisons, and perhaps draw their own conclusions, there would be a conclusiveness to the test, at least to the layman, which is largely lacking in privately conducted tests; and if competent engineers were to prepare their own conclusions in the "calm, judicious atmosphere" of their laboratory offices, their report should be just as fair and just as convincing as if the public had not had an opportunity to scrutinize every step of the test.

We have forced publicity of corporation accounts, not to pry curiously into legitimate business but to safeguard it from the illegitimate acts of competitors. We have forced publicity of campaign contributions, not to curtail the raising of funds for legitimate campaign purposes but to safeguard honest from dishonest office seekers. No body of men is individually and collectively so free from the suspicion of dishonesty as the civil engineering profession, but as long as indeterminate factors and personal judgment must enter into decisions, it is not unreasonable to conduct tests in public as was done at Detroit, and this will serve not only to eliminate the slighest suspicion of bias but will surely bring about a greater measure of confidence between engineer and layman.

The paving determinator test was conducted for the benefit of the layman as well as the engineer. The concrete and the brick sections were each laid by interests to whose advantage it would be to have their sections show up well. The integrity of the conduct of the test is beyond question. As for the conclusions of the test, based upon data taken during the run, it is hard to believe that the report of the members of the civil engineering faculty of the University of Michigan will be other than fair and impartial, identical with what would be expected from a similar test conducted in the semi-secrecy of their own college laboratory.

Where, then, is the "violation of engineering sense"? Is not this openly conducted test a step in advance in engineering? Is it not in line with the open methods now demanded in business and politics? Is it not the form of test which in future may be depended upon to settle conclusively points about which there are differences of opinion which should be unified? True, it is an accelerated test and therefore one from which it is harder to draw true conclusions, but this only amplifies the argument for it.

The results of the test were surprising, and in a way disappointing, to both of the friendly parties interested, but they show one fact so conclusively that it should not be passed over lightly—that the interests promoting concrete pavements have been painstakingly fair, just to competing materials, and willing to risk the defeat of their purpose in a test whose outcome was wholly problematical and dependent, so far as they knew, upon the relative merits of the materials used.

Chicago. Concrete Engineer.